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United States Patent

(12) **United States Patent**
Umezaki et al.

(10) **Patent No.: US 7,986,287 B2**
(45) **Date of Patent: Jul. 26, 2011**

(54) **DISPLAY DEVICE AND METHOD OF DRIVING THE SAME**

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(73) Assignee: **Semiconductor Energy Laboratory Co., Ltd.**, Kanagawa-ken (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 838 days.

(21) Appl. No.: **11/465,251**

(22) Filed: **Aug. 17, 2006**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 26, 2005 (JP) 2005-245467

(51) **Int. Cl.**
G09G 3/32 (2006.01)

(52) **U.S. Cl.** **345/82**; 348/173; 324/403

(58) **Field of Classification Search** 345/76–82, 345/204, 214, 690, 207; 324/760.01–760.02; 349/187–192; 356/5.01–5.04; 348/173
See application file for complete search history.

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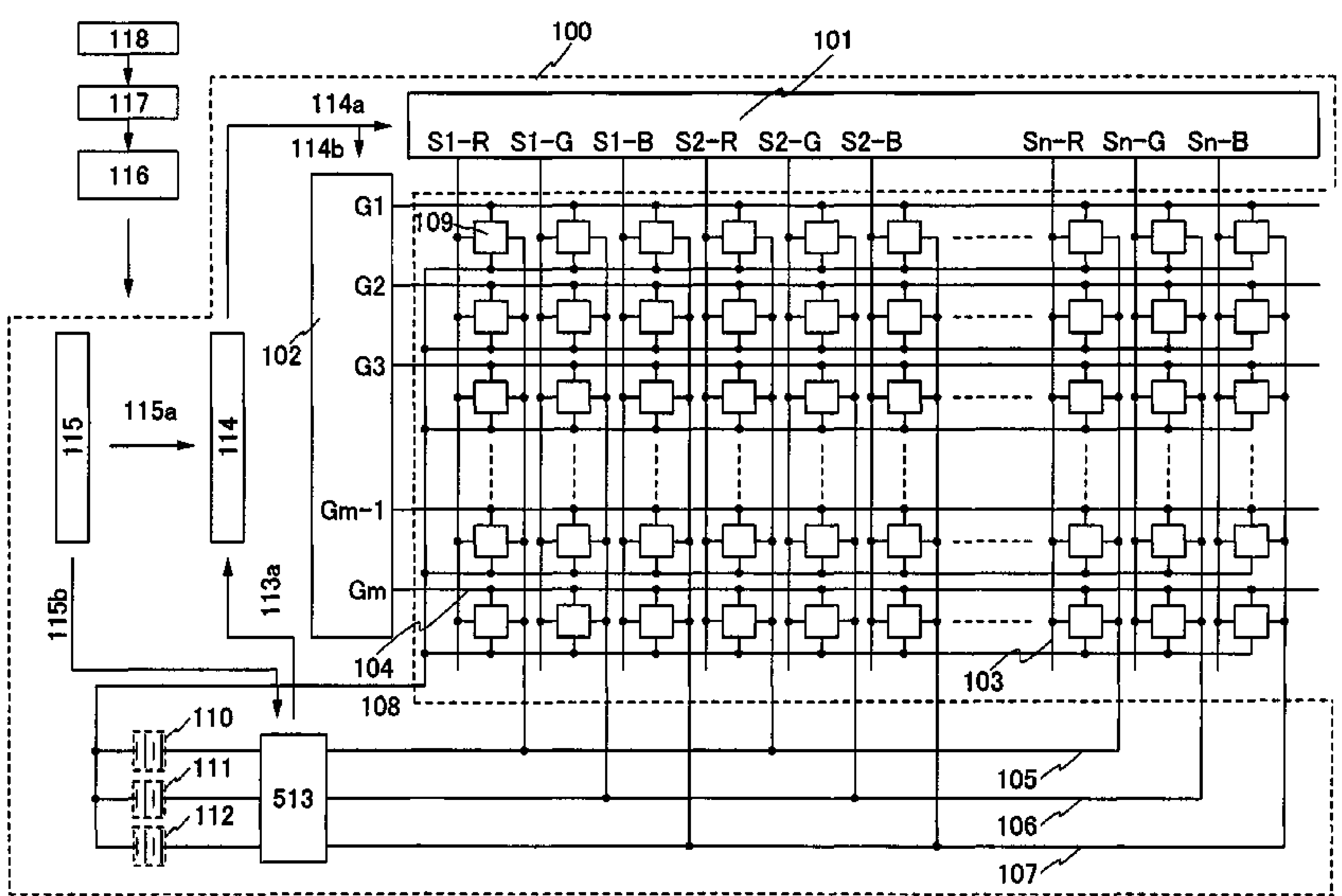
Primary Examiner — Alexander S. Beck
Assistant Examiner — Liliana Cerullo
(74) *Attorney, Agent, or Firm* — Fish & Richardson P.C.

(57) **ABSTRACT**

When a light-emitting element emits light for a long time, characteristics thereof change and current flowing therethrough is reduced even in the same voltage is applied. In particular, in a case of a display device with light-emitting element, there is a problem such that burn-in is generated in a display screen. A burn-in correction period in which characteristics of a light-emitting element in each pixel are detected is provided in addition to a normal driving period in which an image is displayed. The light-emitting element can emit light which compensates the changes in the characteristics, by correcting video signals inputted to each pixel in the normal driving period according to the characteristics of the light-emitting elements obtained in the burn-in correction period.

37 Claims, 82 Drawing Sheets



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WO	WO 2006/011666	A1	2/2006
WO	WO 2006/035953	A1	4/2006

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FIG. 1

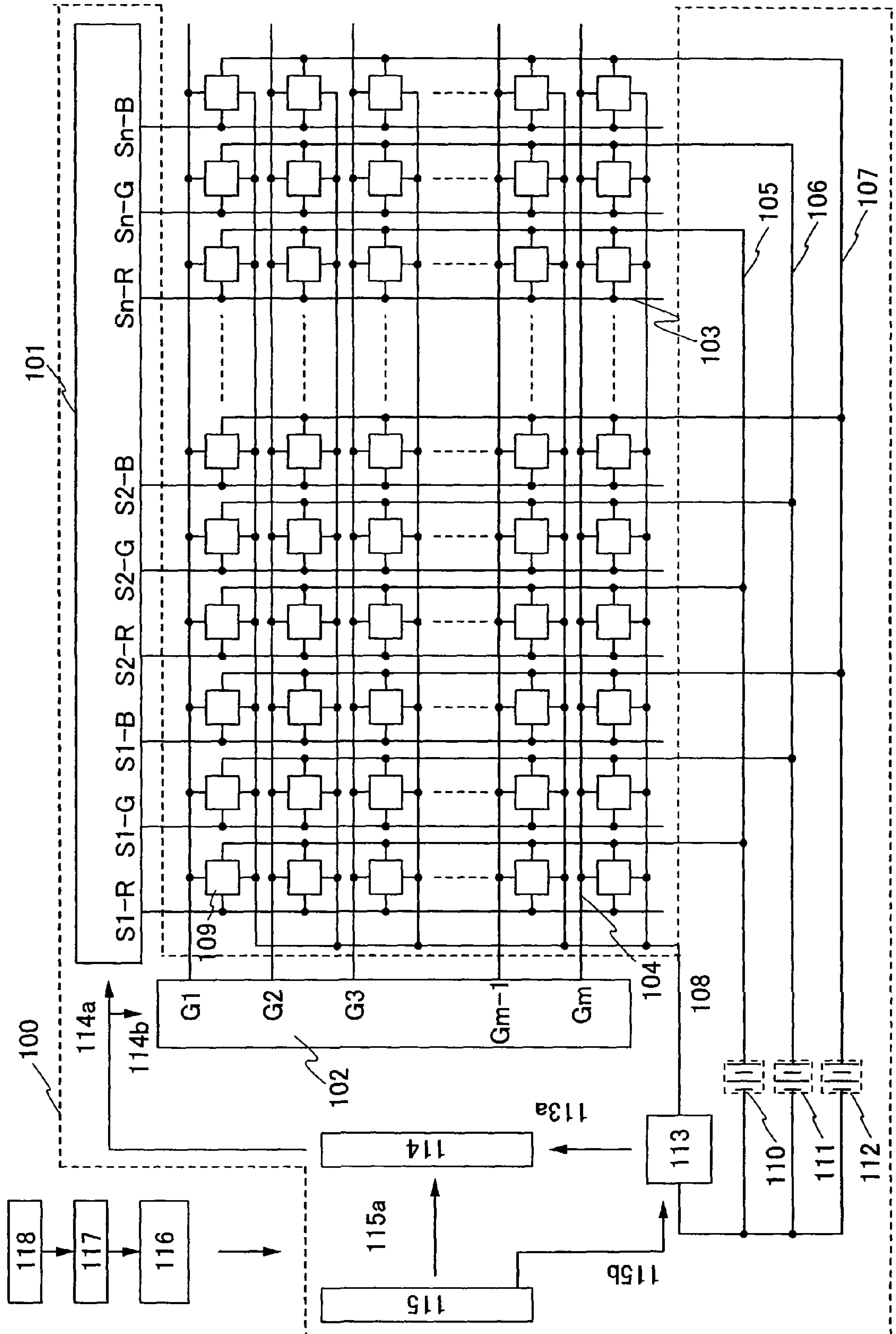

100
101
102
103
104
105
106
107
108
109
110
111
112
113
113a
114
114a
114b
115
115a
115b
116
117
118
S1-R
S1-G
S1-B
S2-R
S2-G
S2-B
Sn-R
Sn-G
Sn-B
G1
G2
G3
Gm-1
Gm

FIG. 2

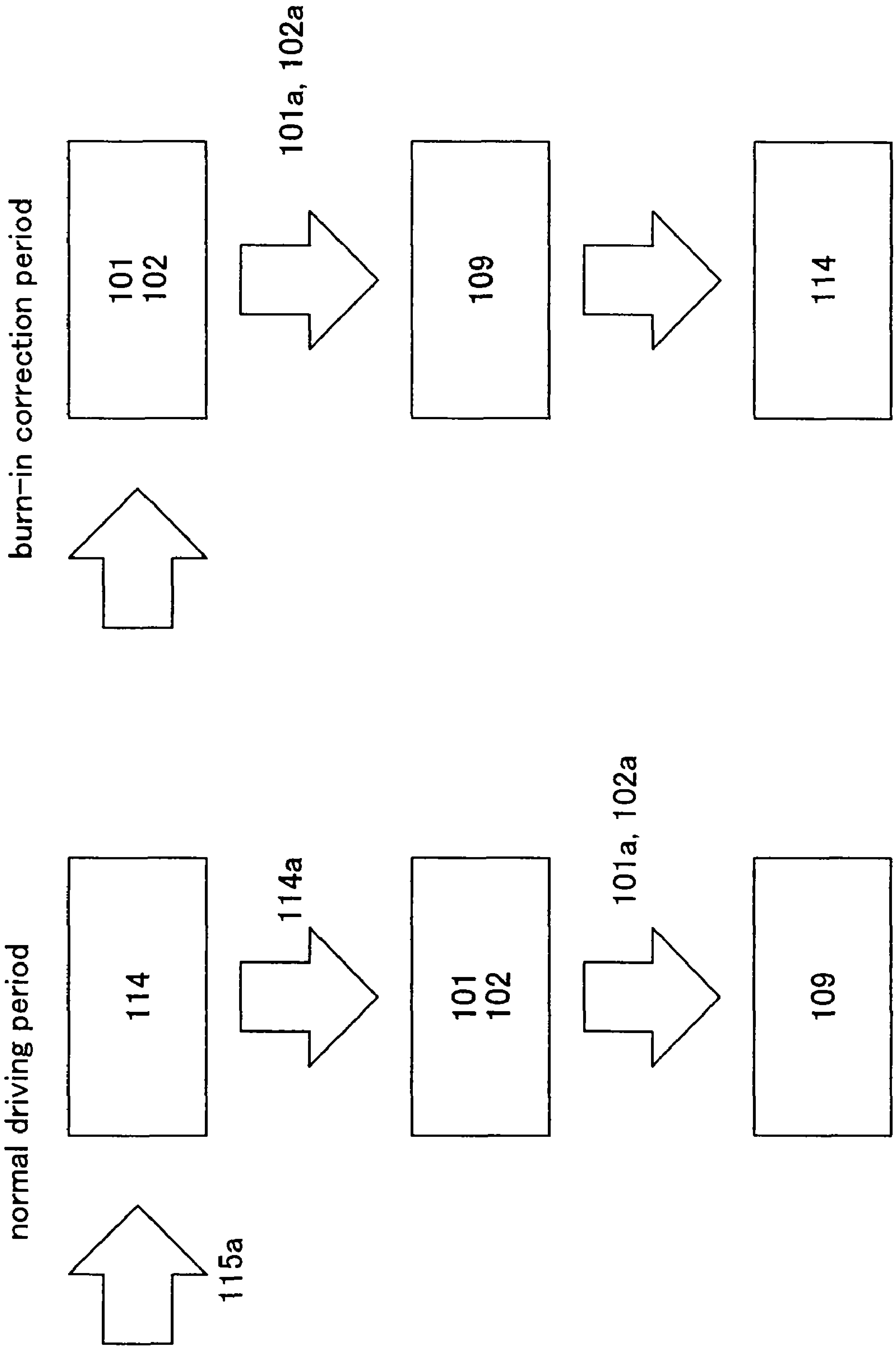

normal driving period
115a
114
114a
101
102
101a, 102a
109
burn-in correction period
101
102
101a, 102a
109
114

FIG. 3

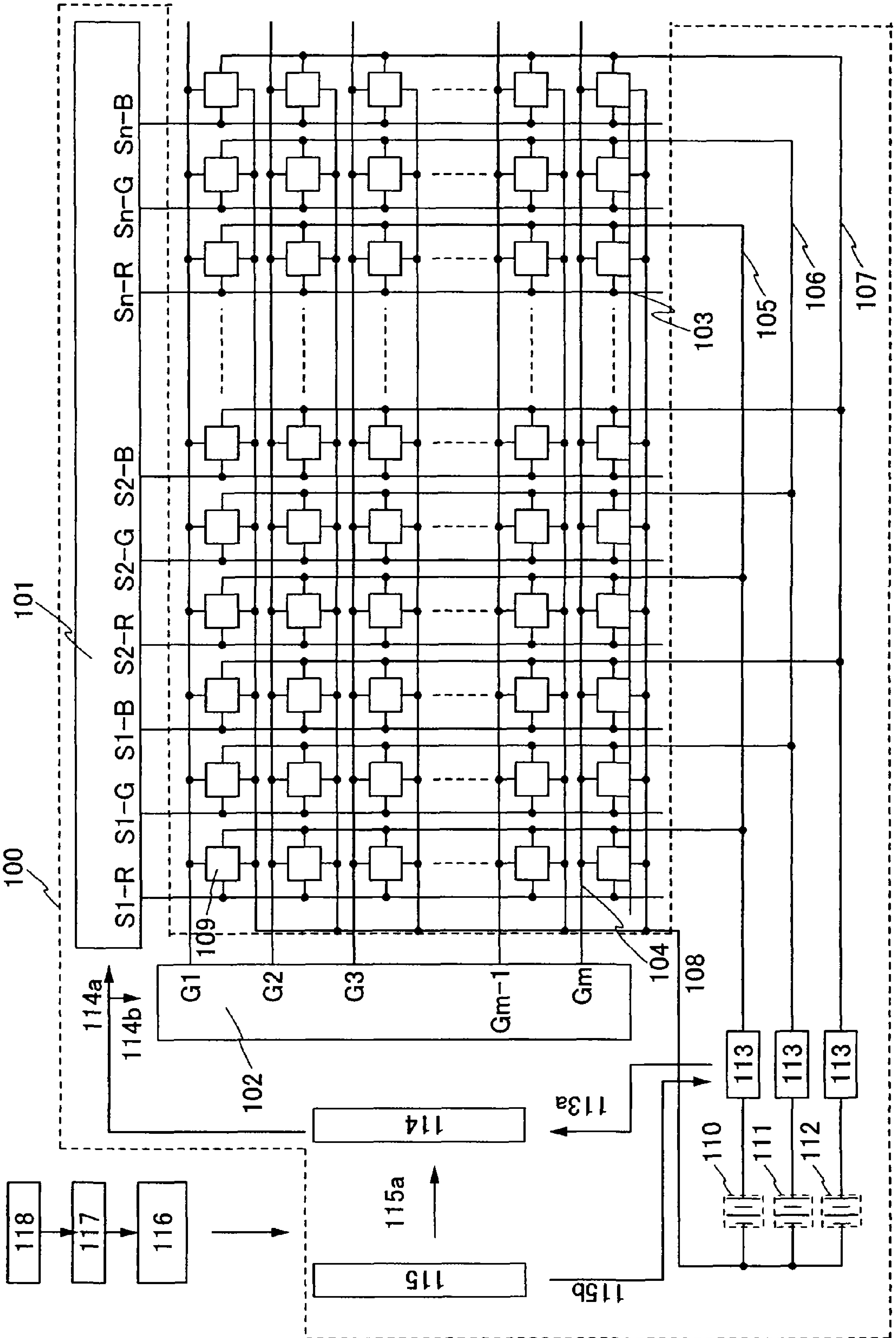

S1-R
S1-G
S1-B
S2-R
S2-G
S2-B
Sn-R
Sn-G
Sn-B
G1
G2
G3
Gm-1
Gm
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
114a
114b
113a
115
115a
115b
116
117
118

FIG. 4

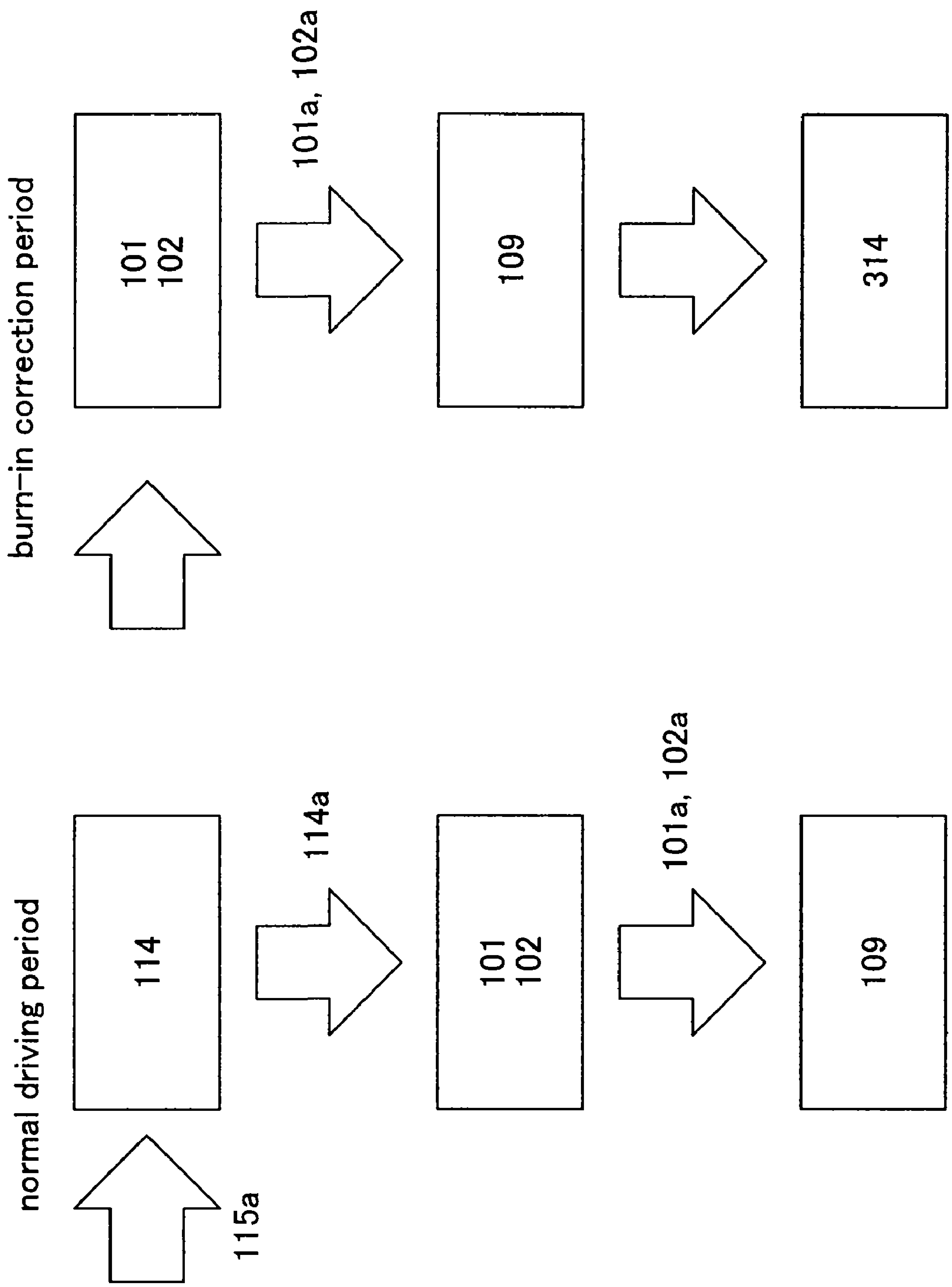

normal driving period
115a
114
114a
101
102
101a, 102a
109
burn-in correction period
101
102
101a, 102a
109
314

FIG. 5

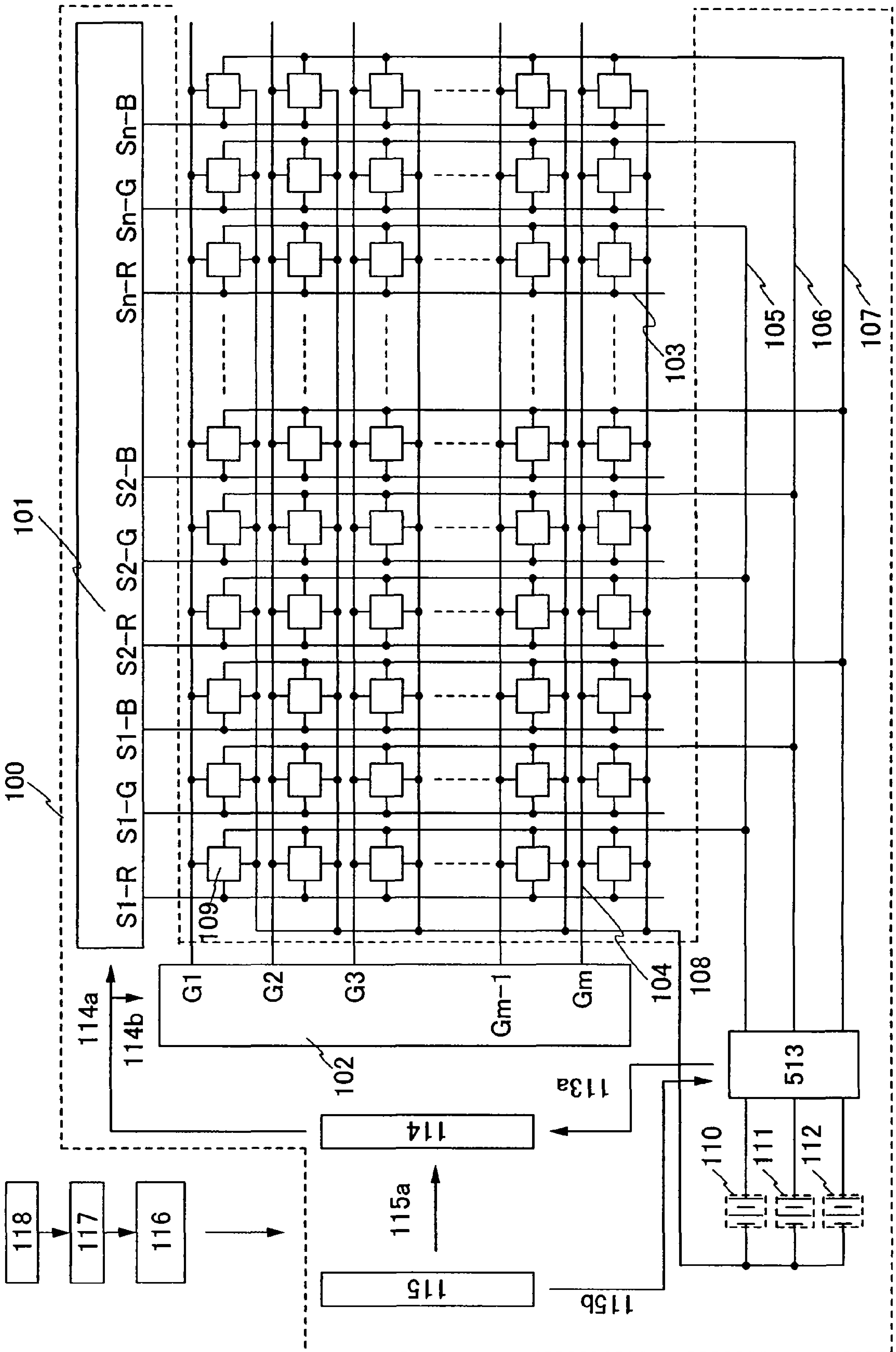

100
101
S1-R S1-G S1-B S2-R S2-G S2-B Sn-R Sn-G Sn-B
103
105
106
107
104
108
109
G1
G2
G3
Gm-1
Gm
102
114a
114b
113a
513
114
110
111
112
115a
115
115b
118
117
116

FIG. 6

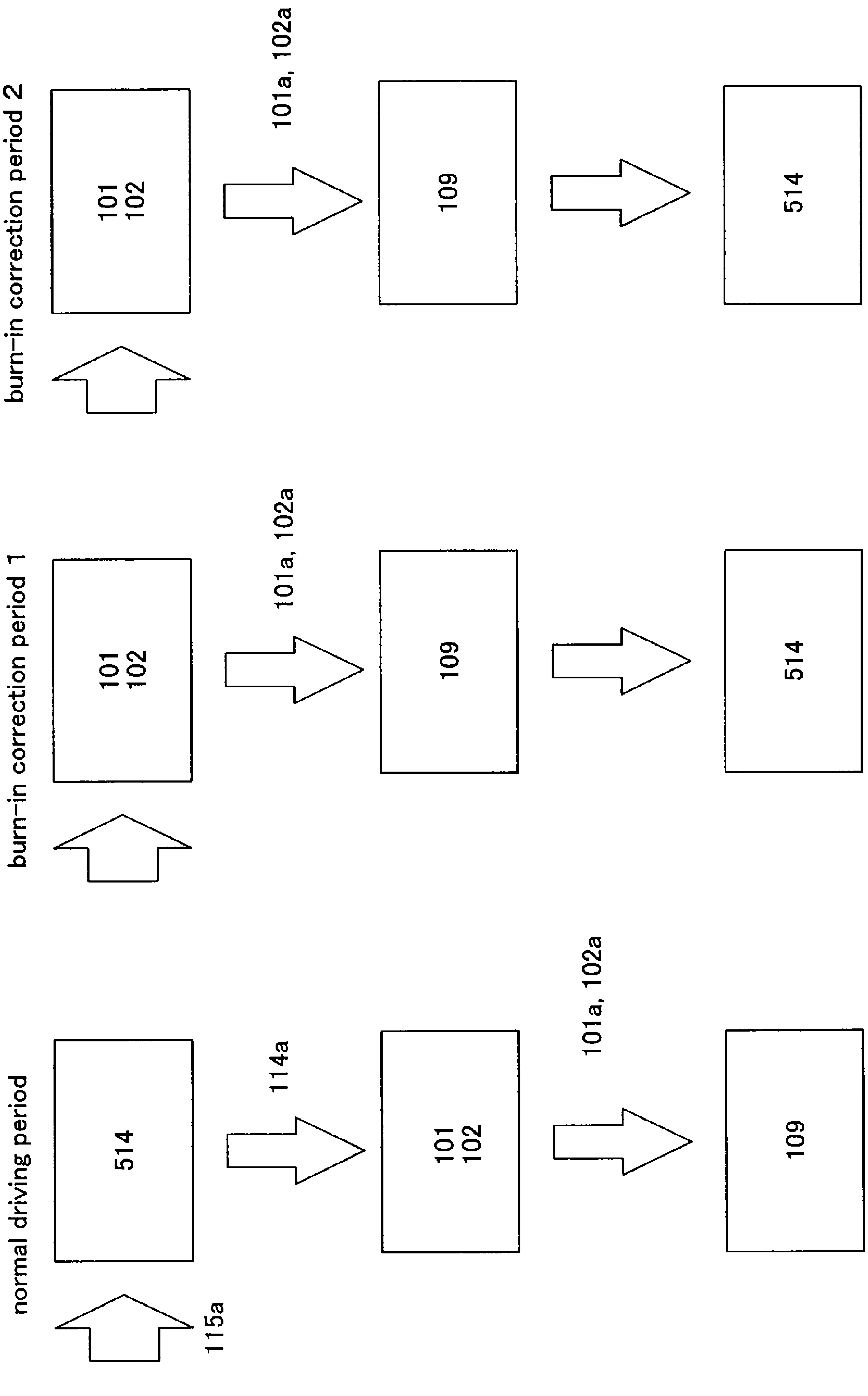

normal driving period
115a
514
114a
101
102
101a, 102a
109
burn-in correction period 1
101
102
101a, 102a
109
514
burn-in correction period 2
101
102
101a, 102a
109
514

FIG. 7

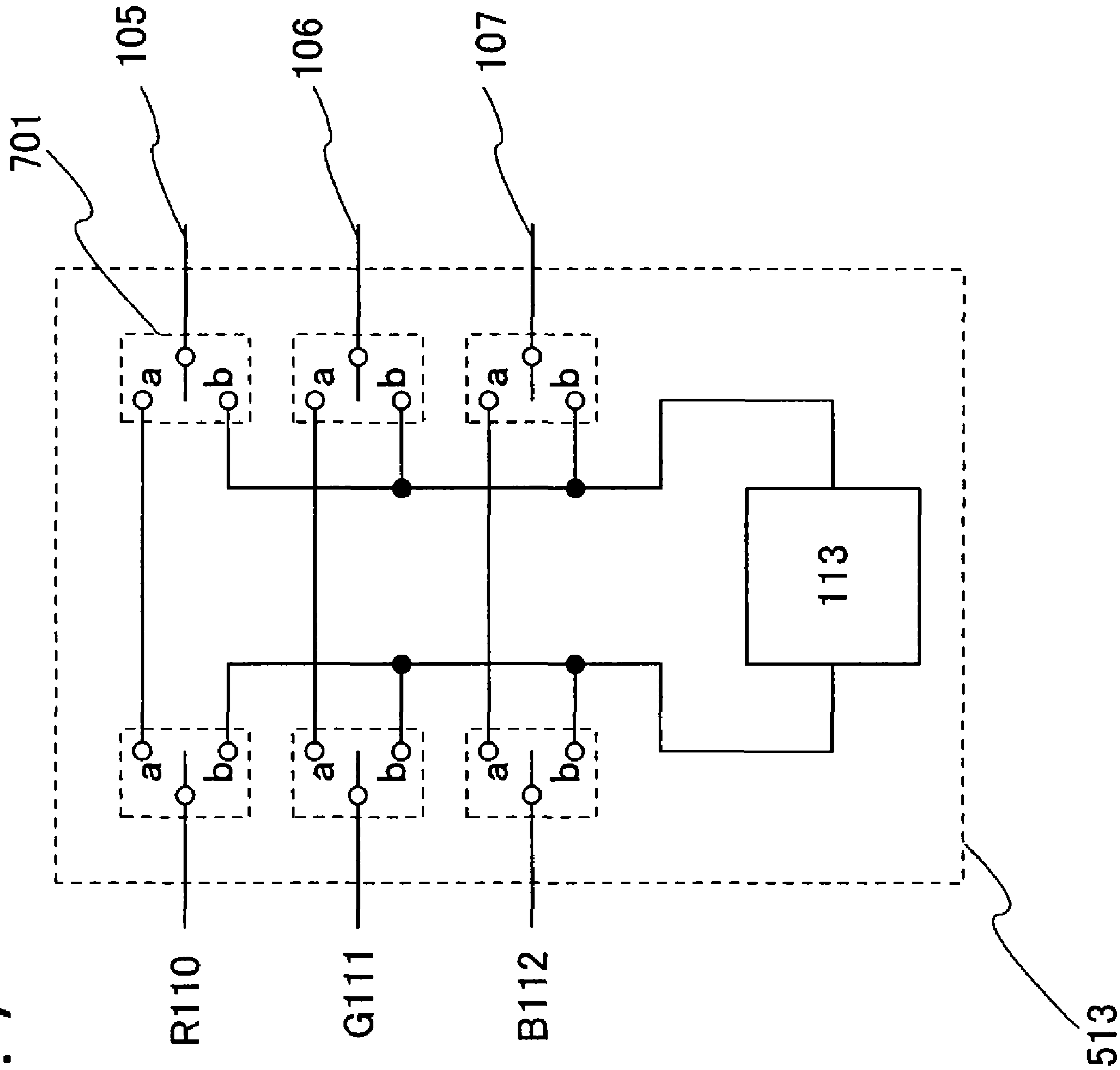


FIG. 8

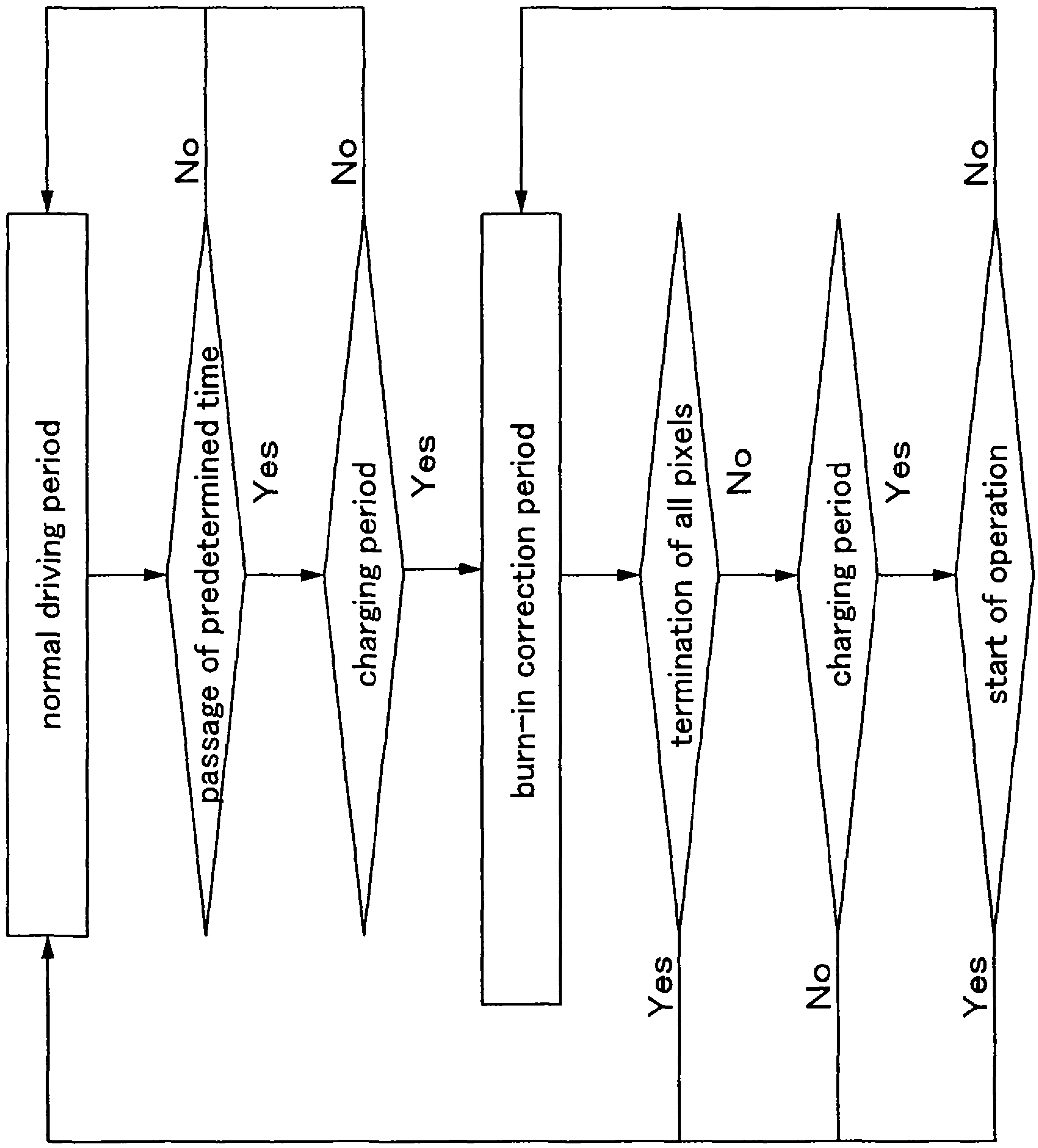

normal driving period
passage of predetermined time
Yes
No
charging period
Yes
No
burn-in correction period
termination of all pixels
No
Yes
charging period
Yes
No
start of operation
Yes
No

FIG. 9

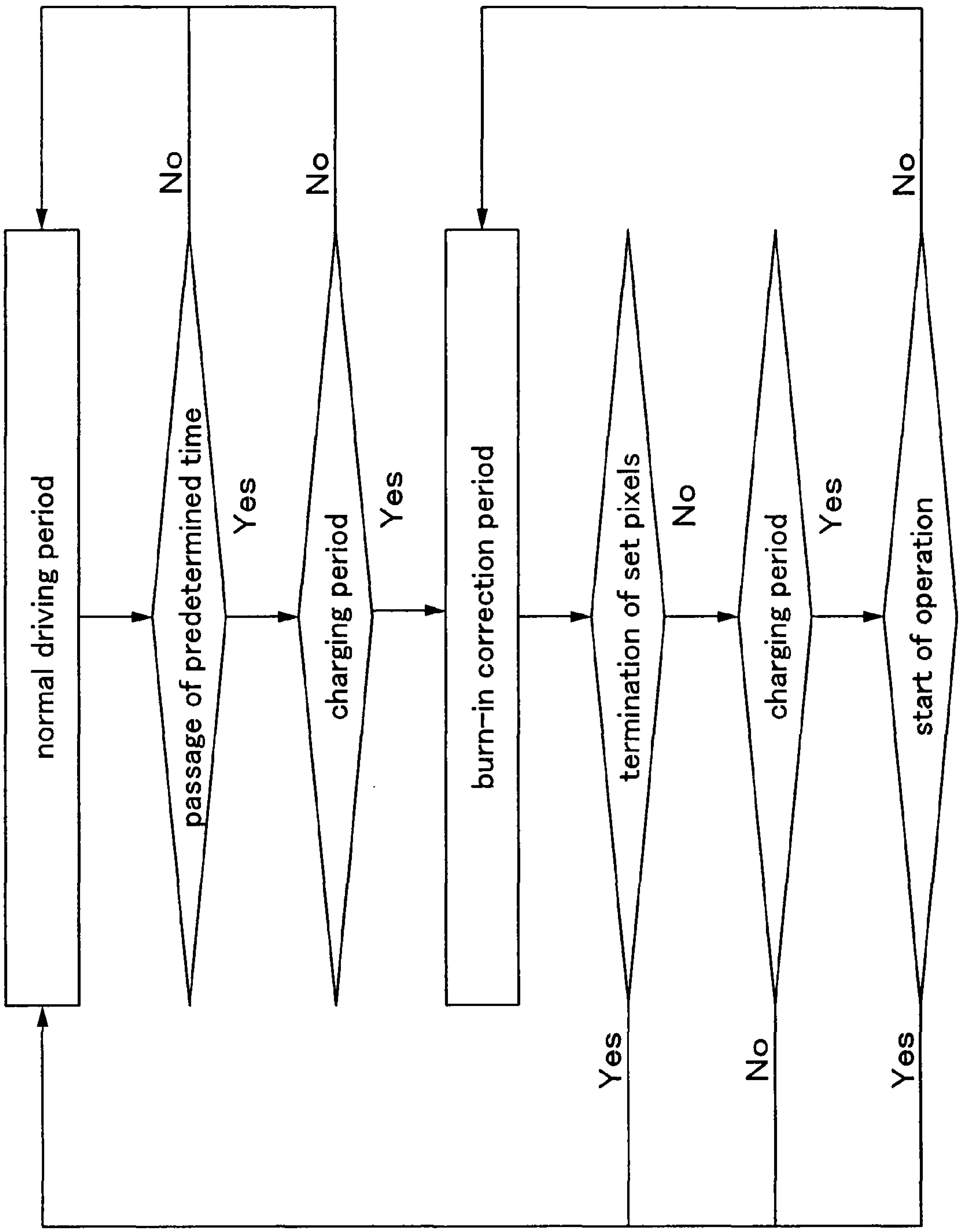

normal driving period
passage of predetermined time
Yes
No
charging period
Yes
No
burn-in correction period
termination of set pixels
No
Yes
charging period
Yes
No
start of operation
Yes
No

FIG. 10

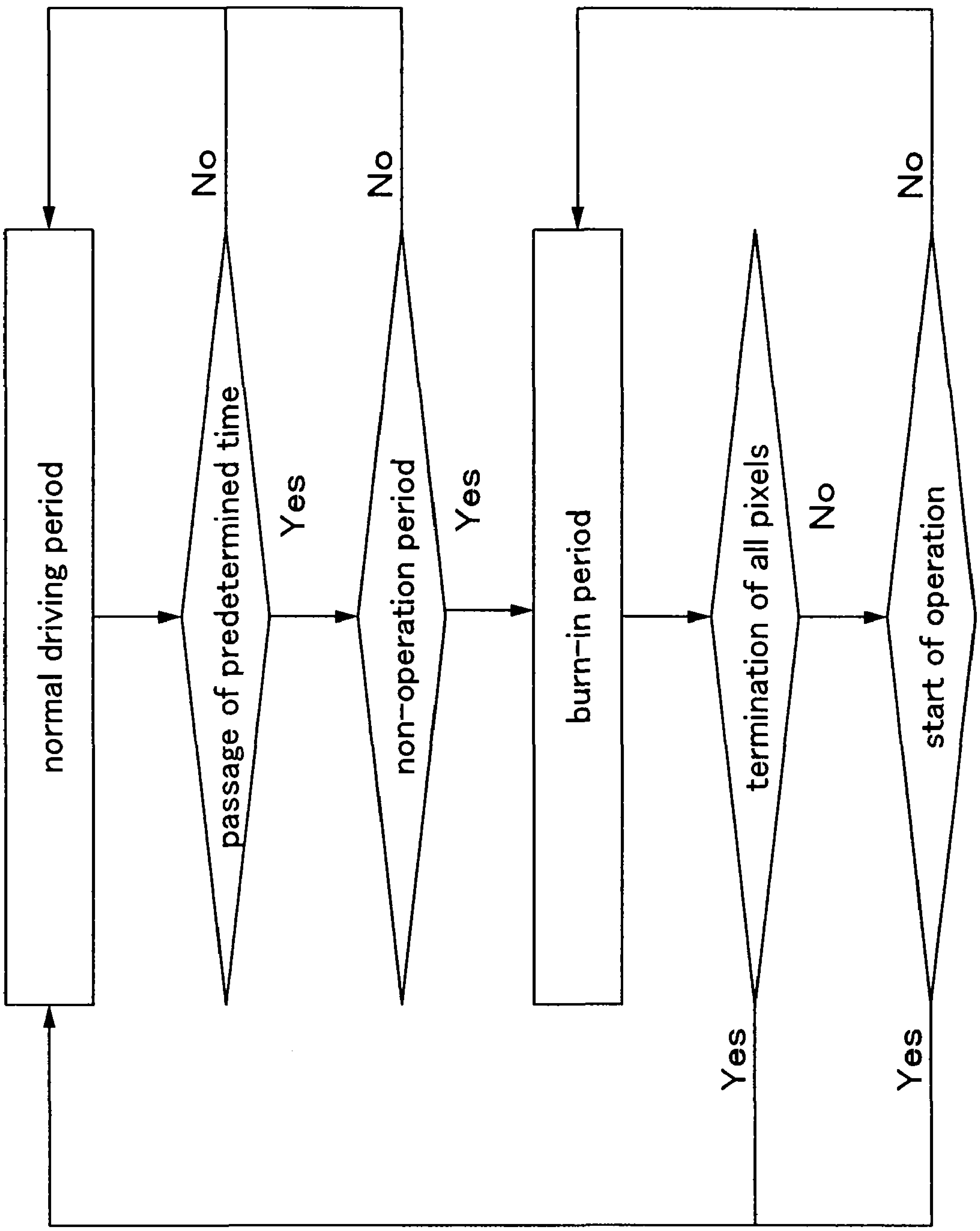

normal driving period
passage of predetermined time
No
Yes
non-operation period
No
Yes
burn-in period
termination of all pixels
No
Yes
start of operation
No
Yes

FIG. 11

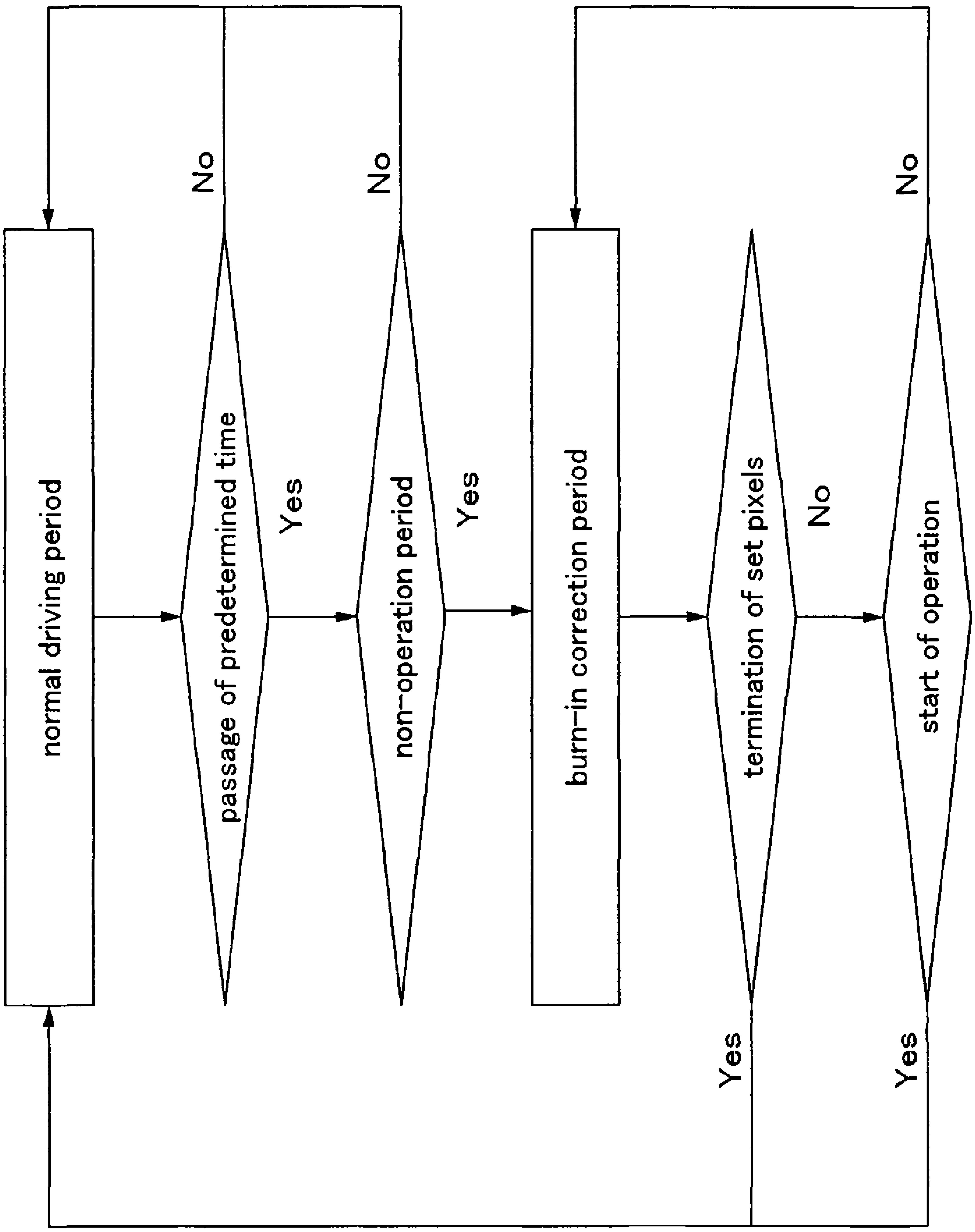

normal driving period
passage of predetermined time
No
Yes
non-operation period
No
Yes
burn-in correction period
termination of set pixels
Yes
No
start of operation
No
Yes

FIG. 12

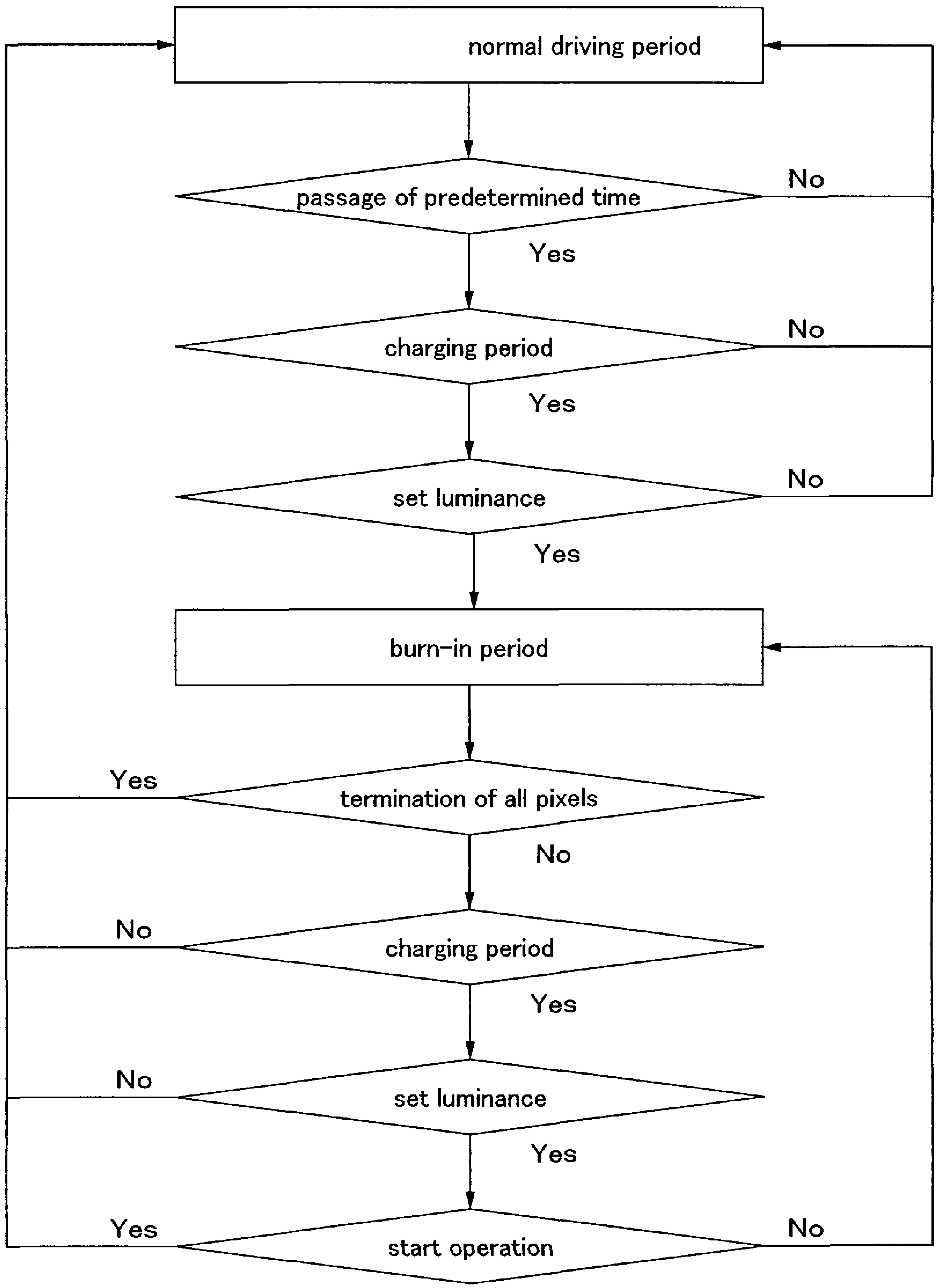

normal driving period
passage of predetermined time
No
Yes
charging period
No
Yes
set luminance
No
Yes
burn-in period
Yes
termination of all pixels
No
No
charging period
Yes
No
set luminance
Yes
Yes
start operation
No

FIG. 13

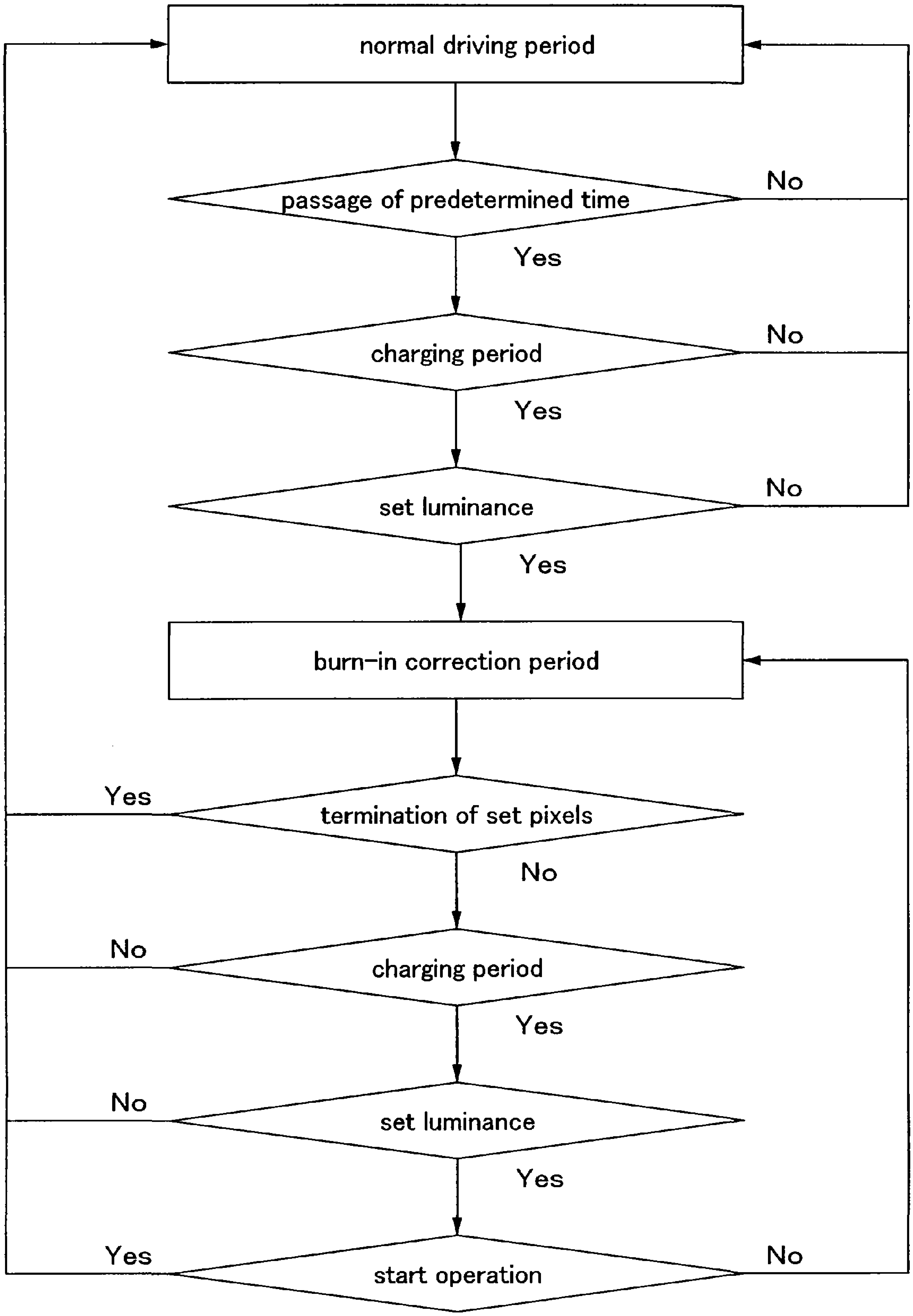

normal driving period
passage of predetermined time
No
Yes
charging period
No
Yes
set luminance
No
Yes
burn-in correction period
termination of set pixels
Yes
No
charging period
No
Yes
set luminance
No
Yes
start operation
Yes
No

FIG. 14

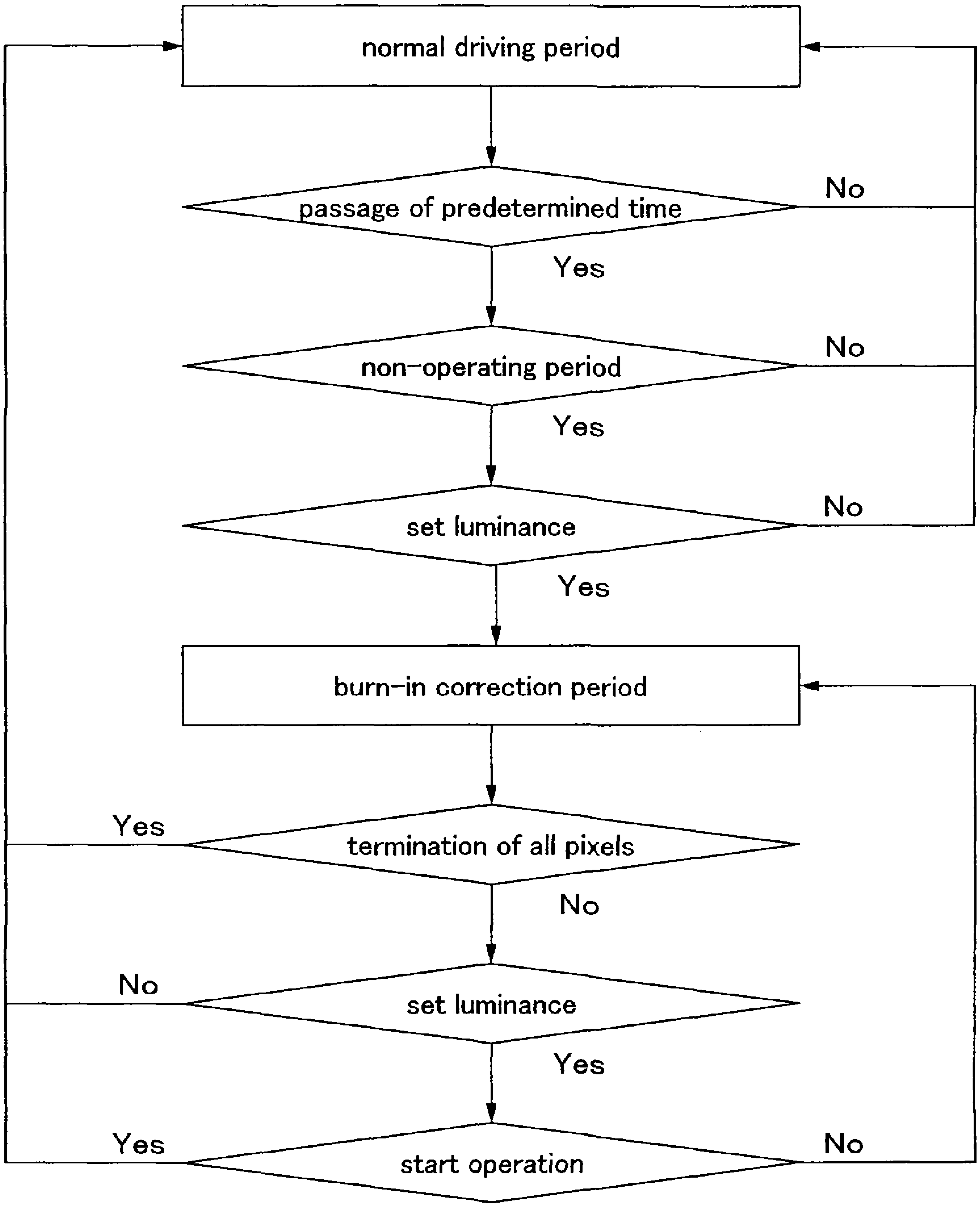

normal driving period
passage of predetermined time
No
Yes
non-operating period
No
Yes
set luminance
No
Yes
burn-in correction period
termination of all pixels
Yes
No
set luminance
No
Yes
start operation
Yes
No

FIG. 15

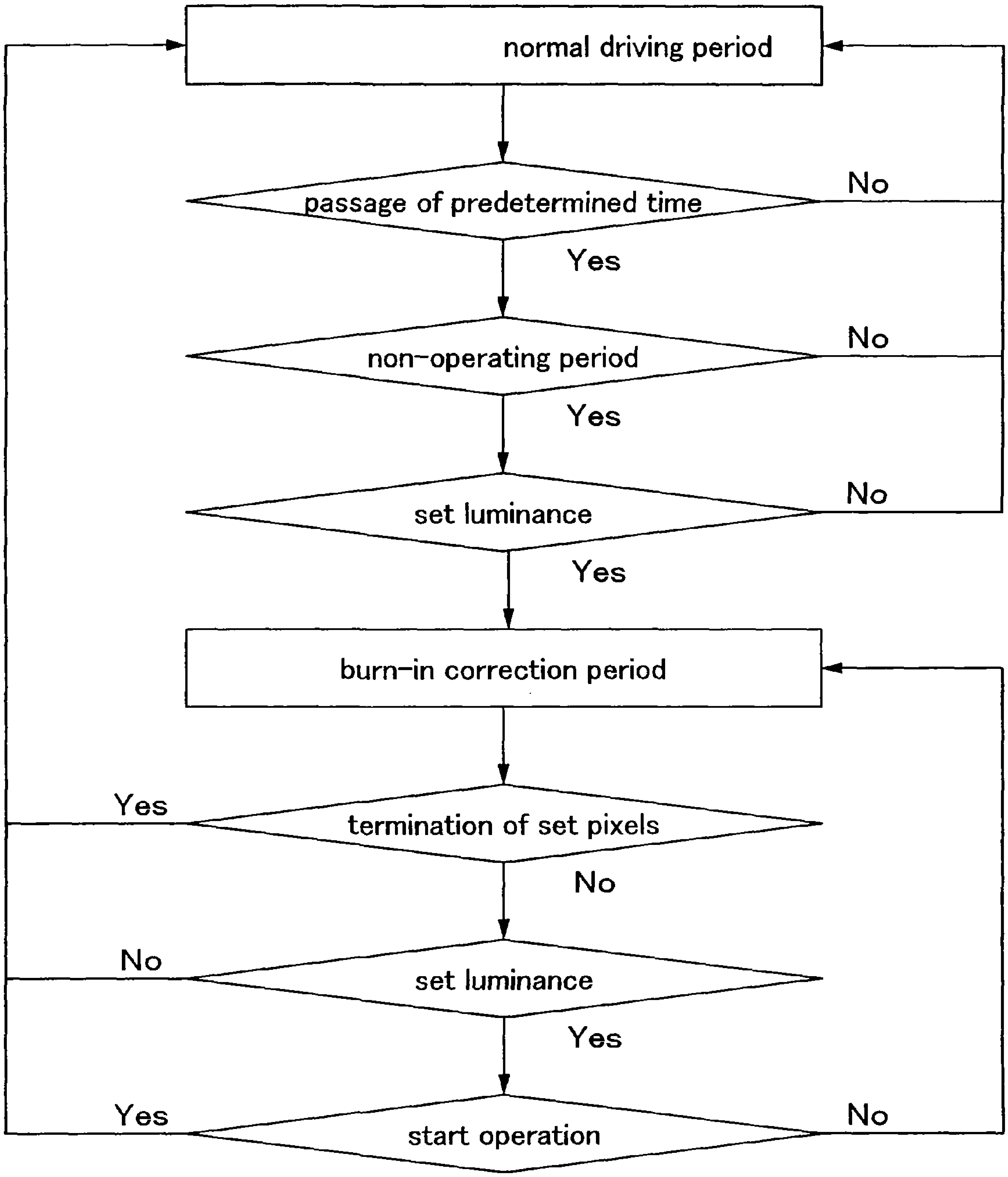

normal driving period
passage of predetermined time
No
Yes
non-operating period
No
Yes
set luminance
No
Yes
burn-in correction period
termination of set pixels
Yes
No
set luminance
No
Yes
start operation
Yes
No

FIG. 16

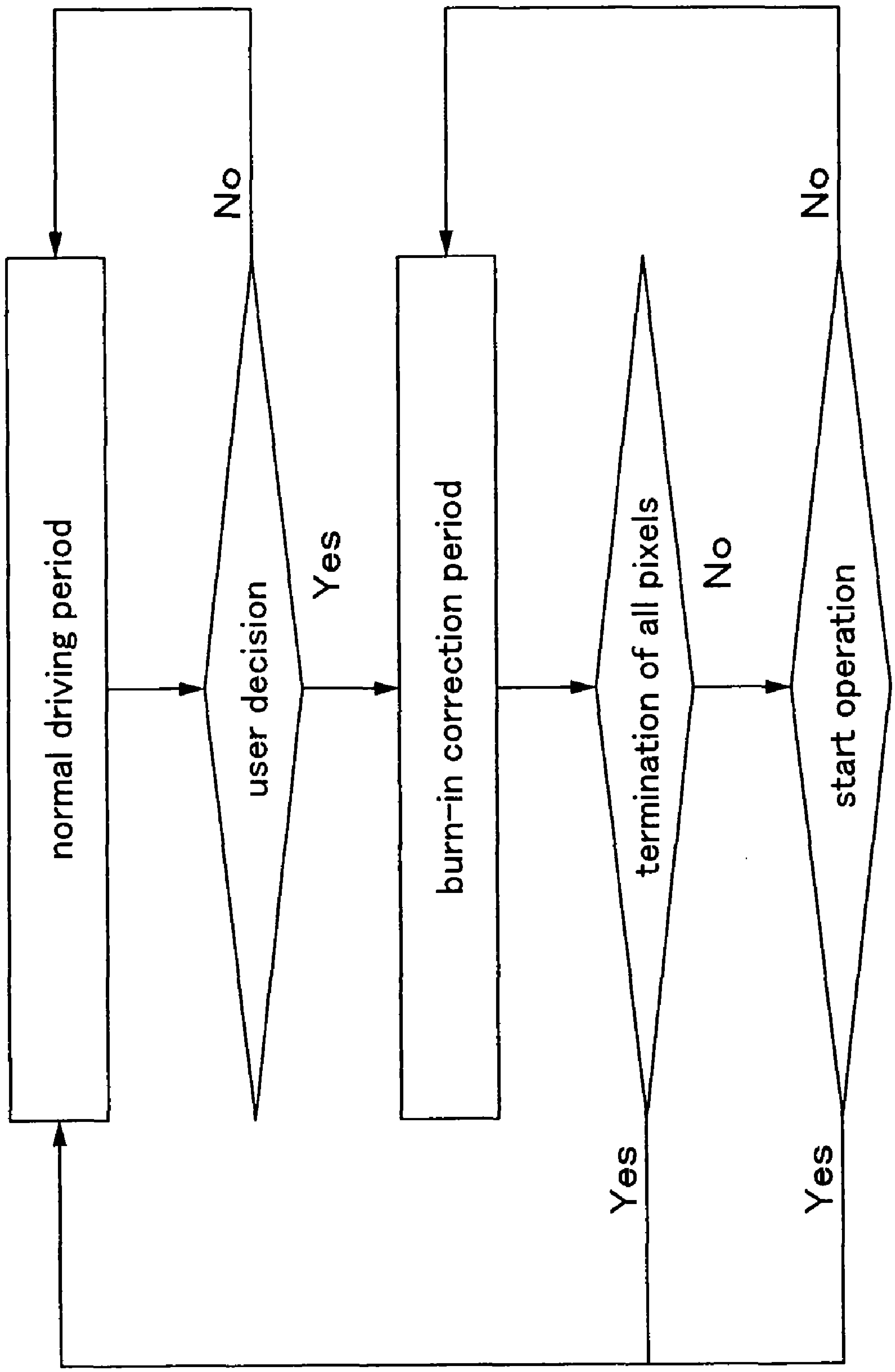

normal driving period
user decision
No
Yes
burn-in correction period
termination of all pixels
No
Yes
start operation
No
Yes

FIG. 17

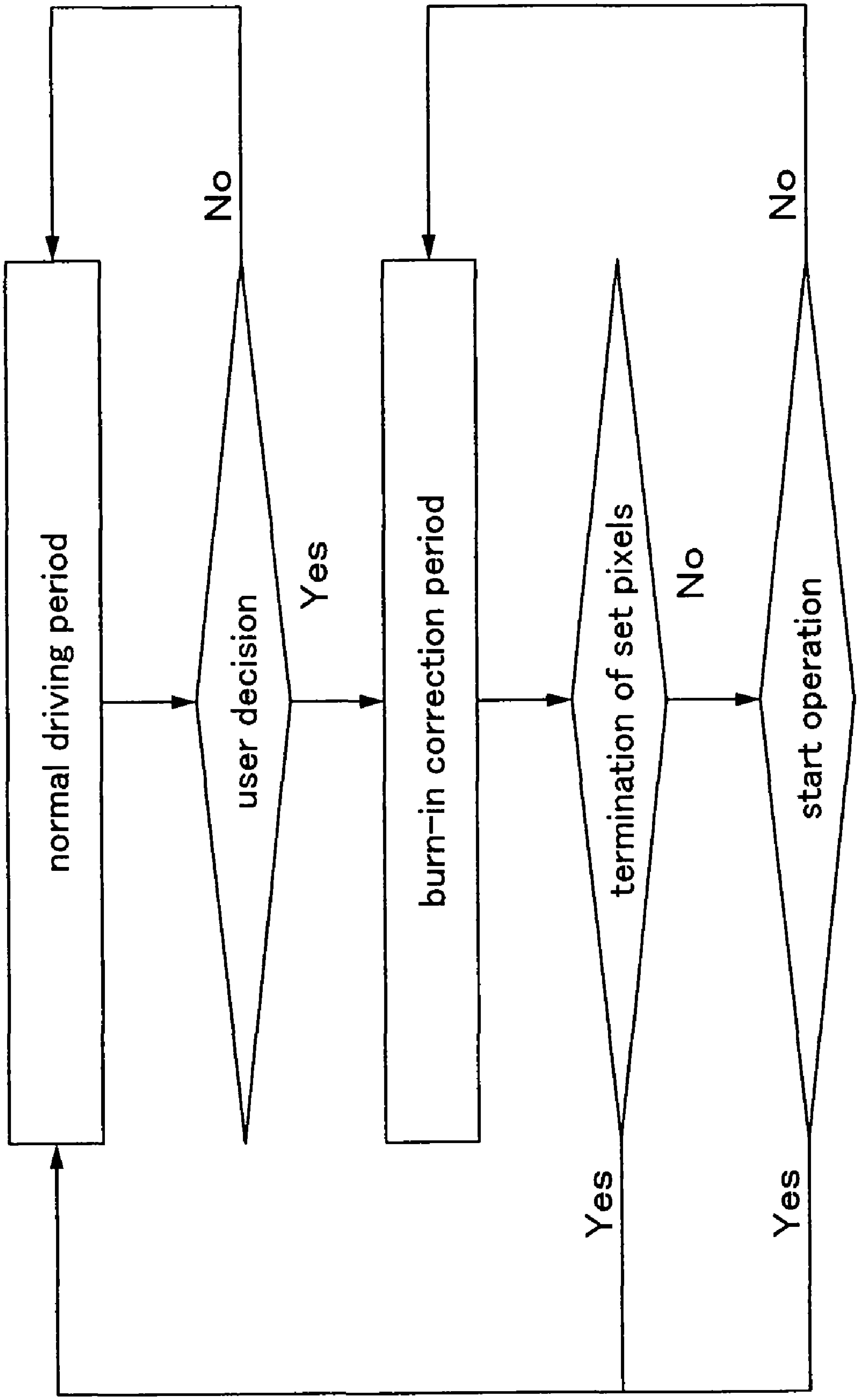

normal driving period
user decision
Yes
No
burn-in correction period
termination of set pixels
No
Yes
start operation
No
Yes

FIG. 18

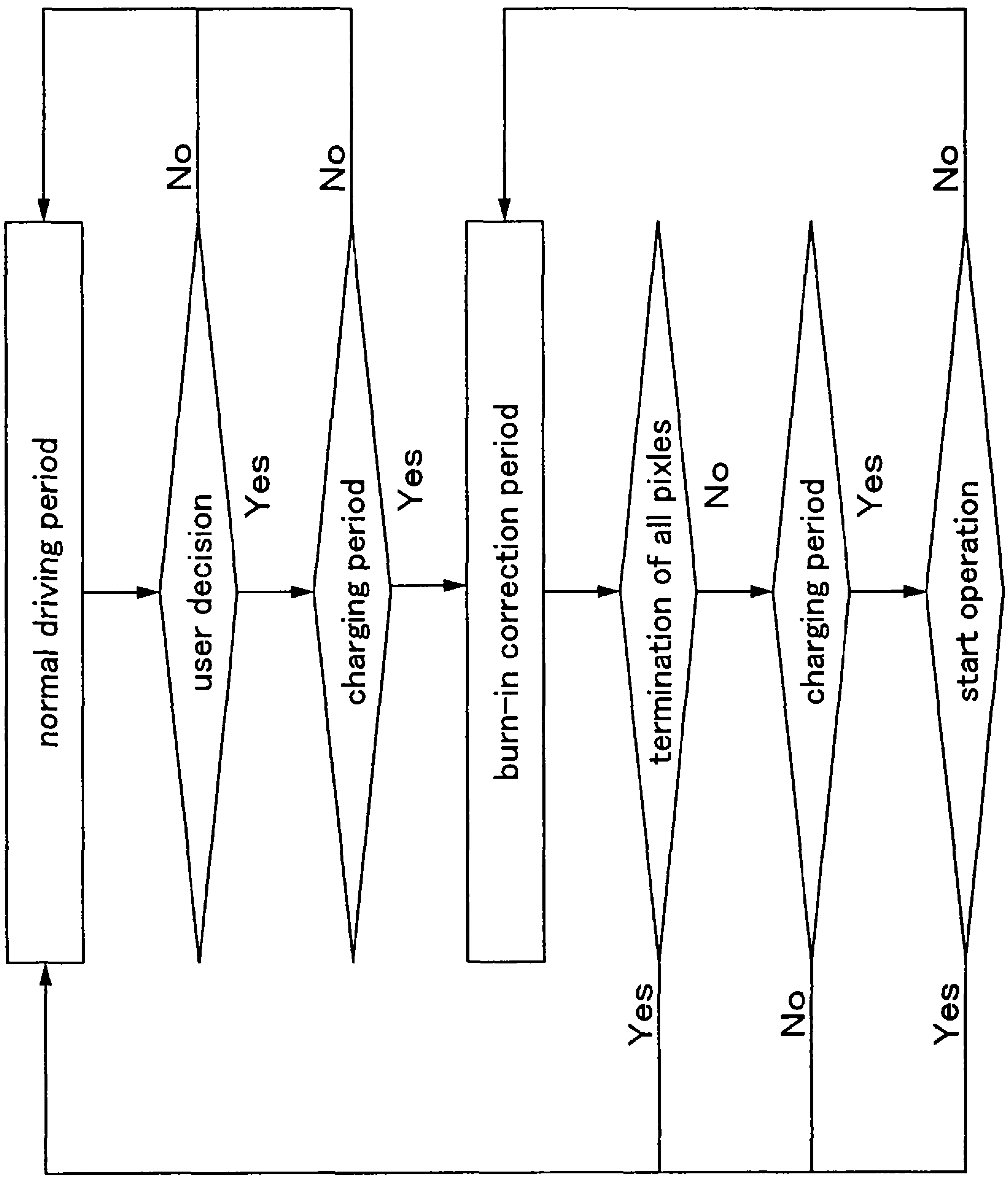

normal driving period
user decision
Yes
No
charging period
Yes
No
burn-in correction period
termination of all pixles
No
Yes
charging period
Yes
No
start operation
No
Yes

FIG. 19

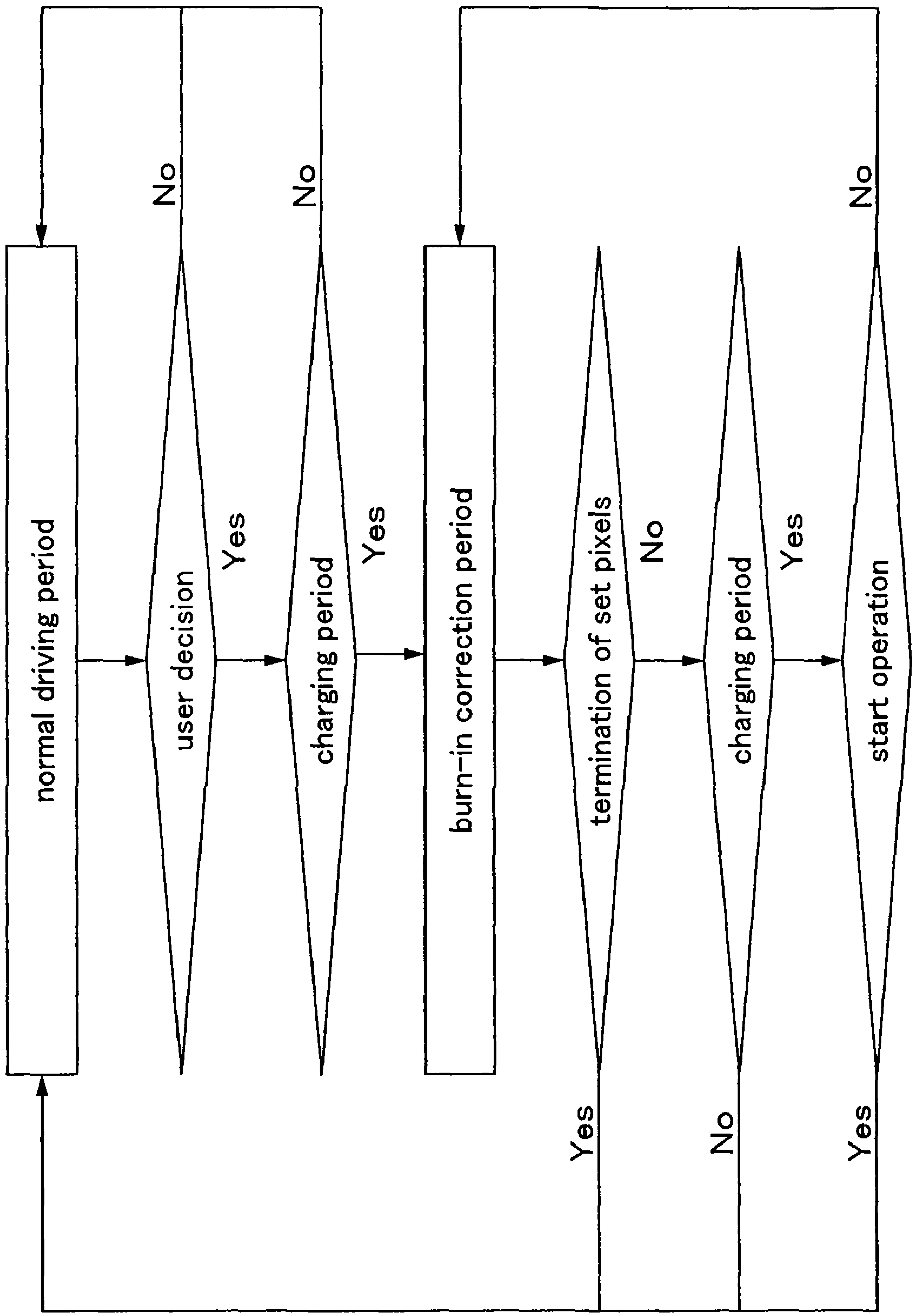

normal driving period
user decision
Yes
No
charging period
Yes
No
burn-in correction period
termination of set pixels
No
Yes
charging period
Yes
No
start operation
No
Yes

FIG. 20

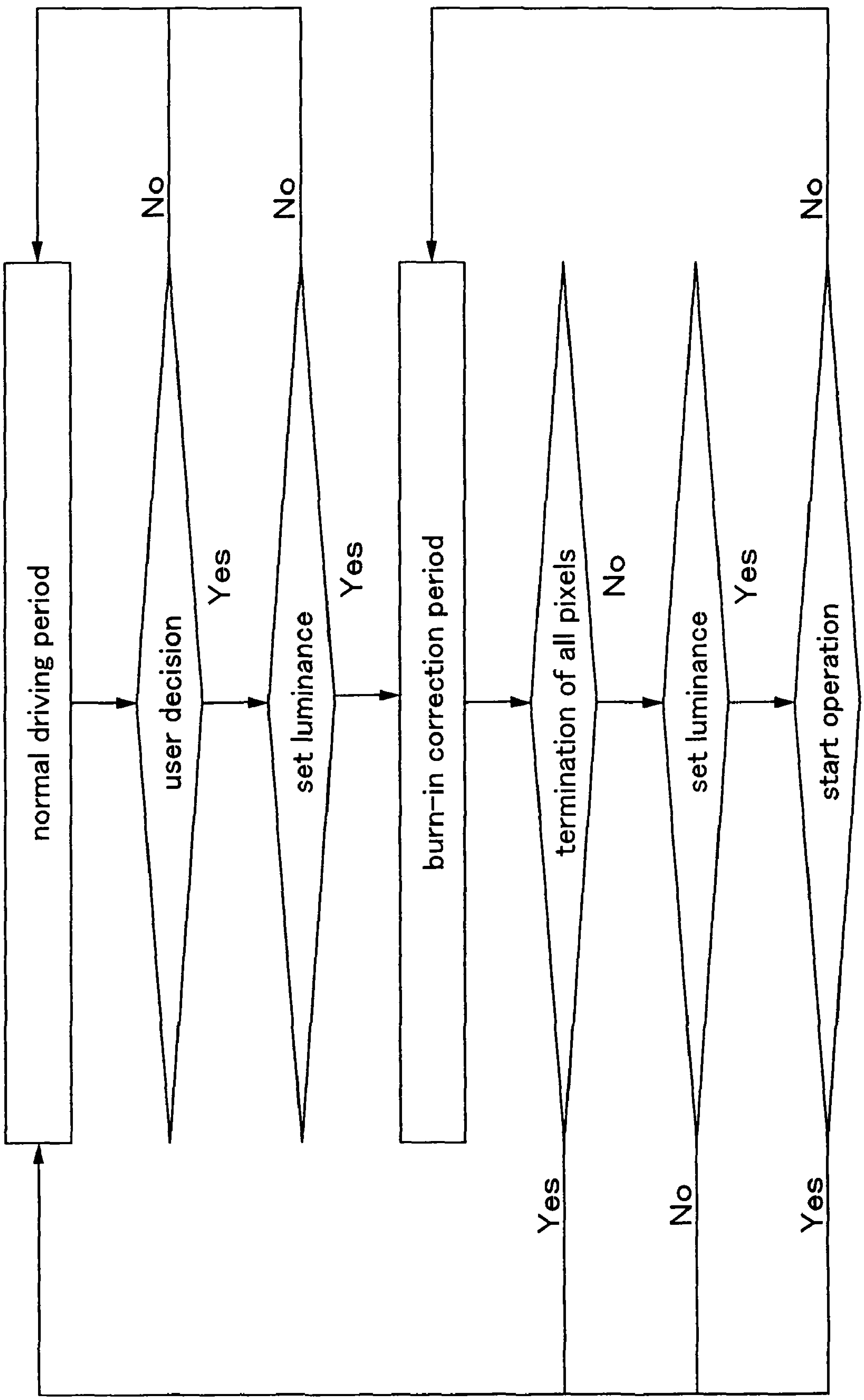

normal driving period
user decision
Yes
No
set luminance
Yes
No
burn-in correction period
termination of all pixels
No
Yes
set luminance
Yes
No
start operation
No
Yes

FIG. 21

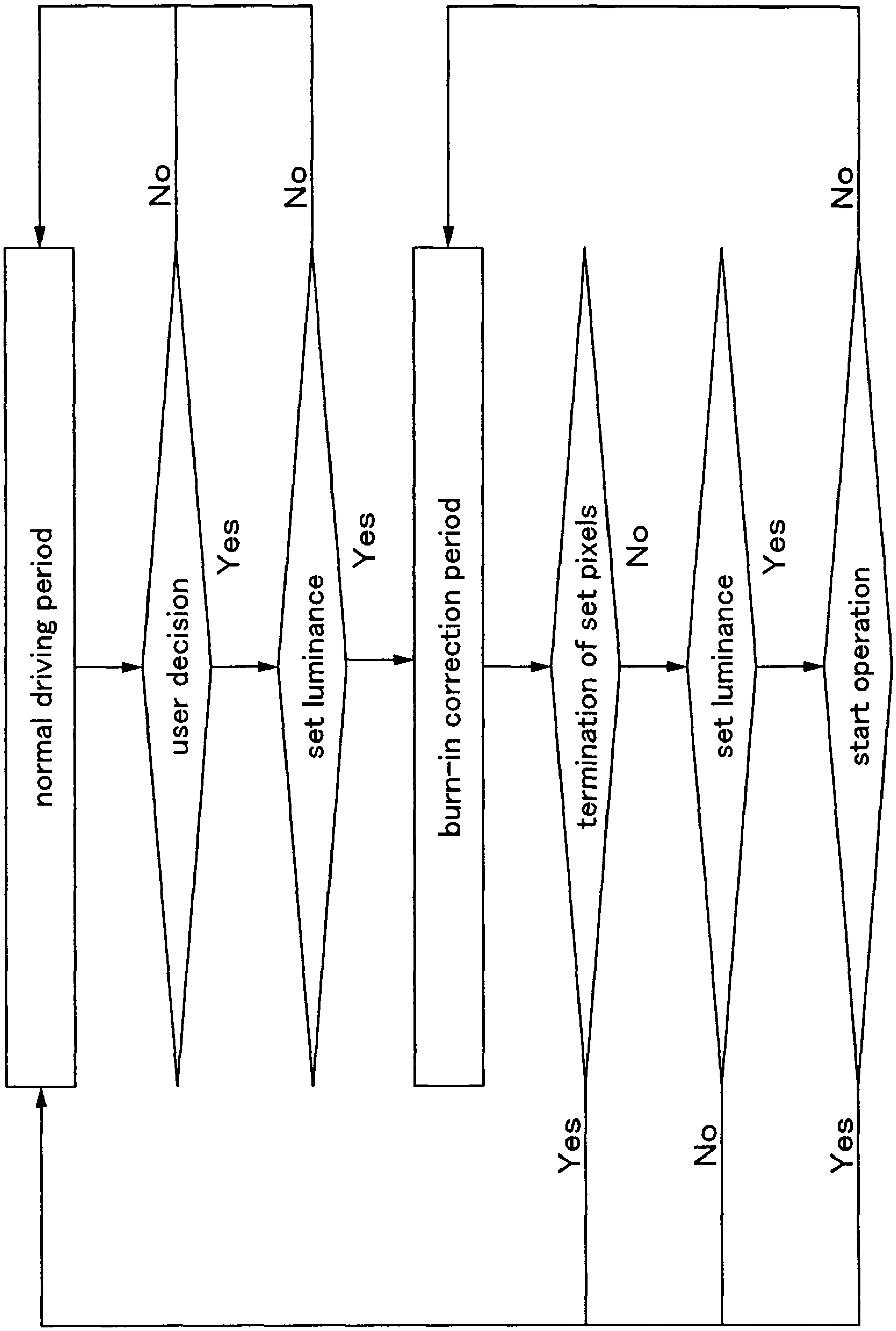

normal driving period
user decision
Yes
No
set luminance
Yes
No
burn-in correction period
termination of set pixels
No
Yes
set luminance
Yes
No
start operation
No
Yes

FIG. 22

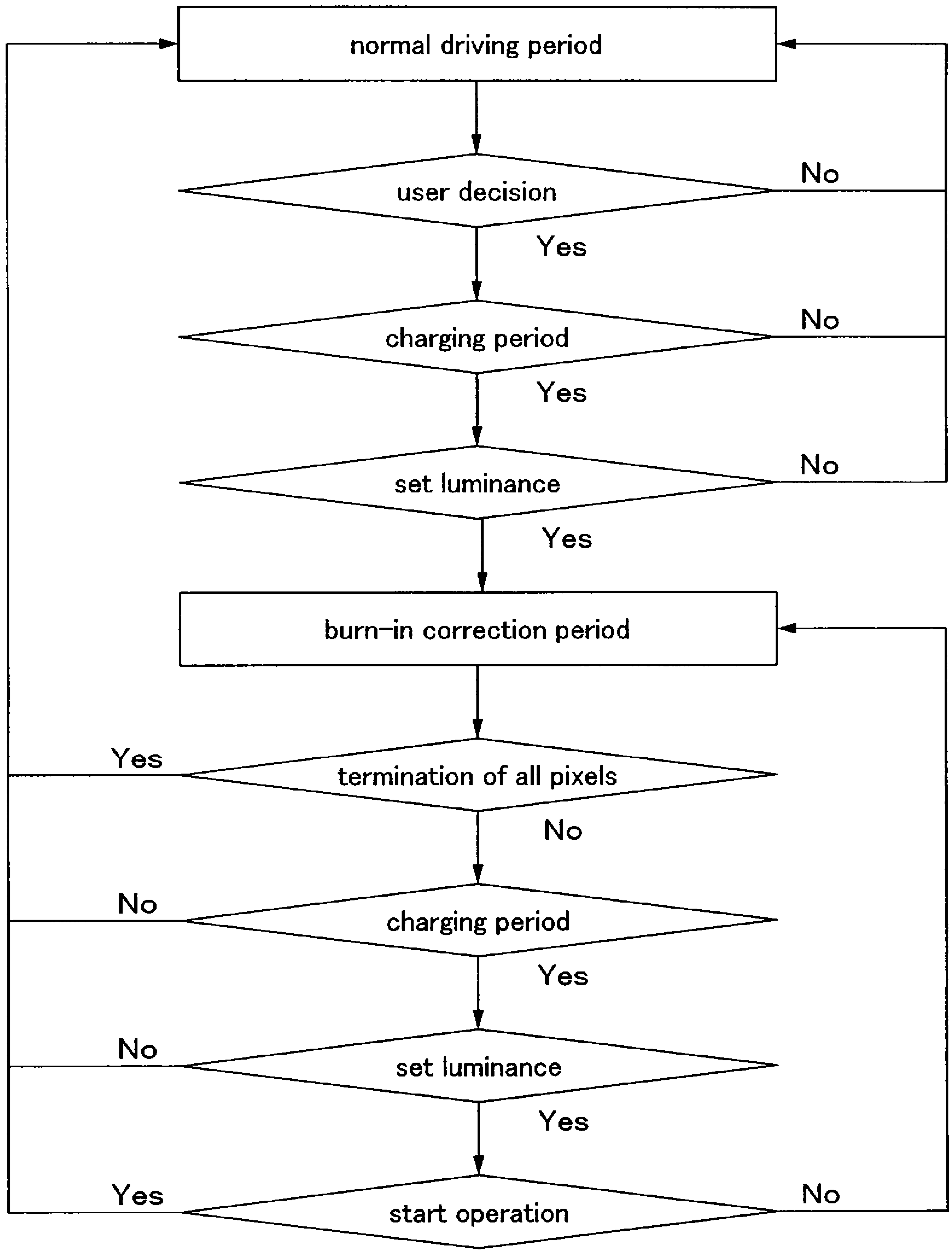

normal driving period
user decision
No
Yes
charging period
No
Yes
set luminance
No
Yes
burn-in correction period
Yes
termination of all pixels
No
No
charging period
Yes
No
set luminance
Yes
Yes
start operation
No

FIG. 23

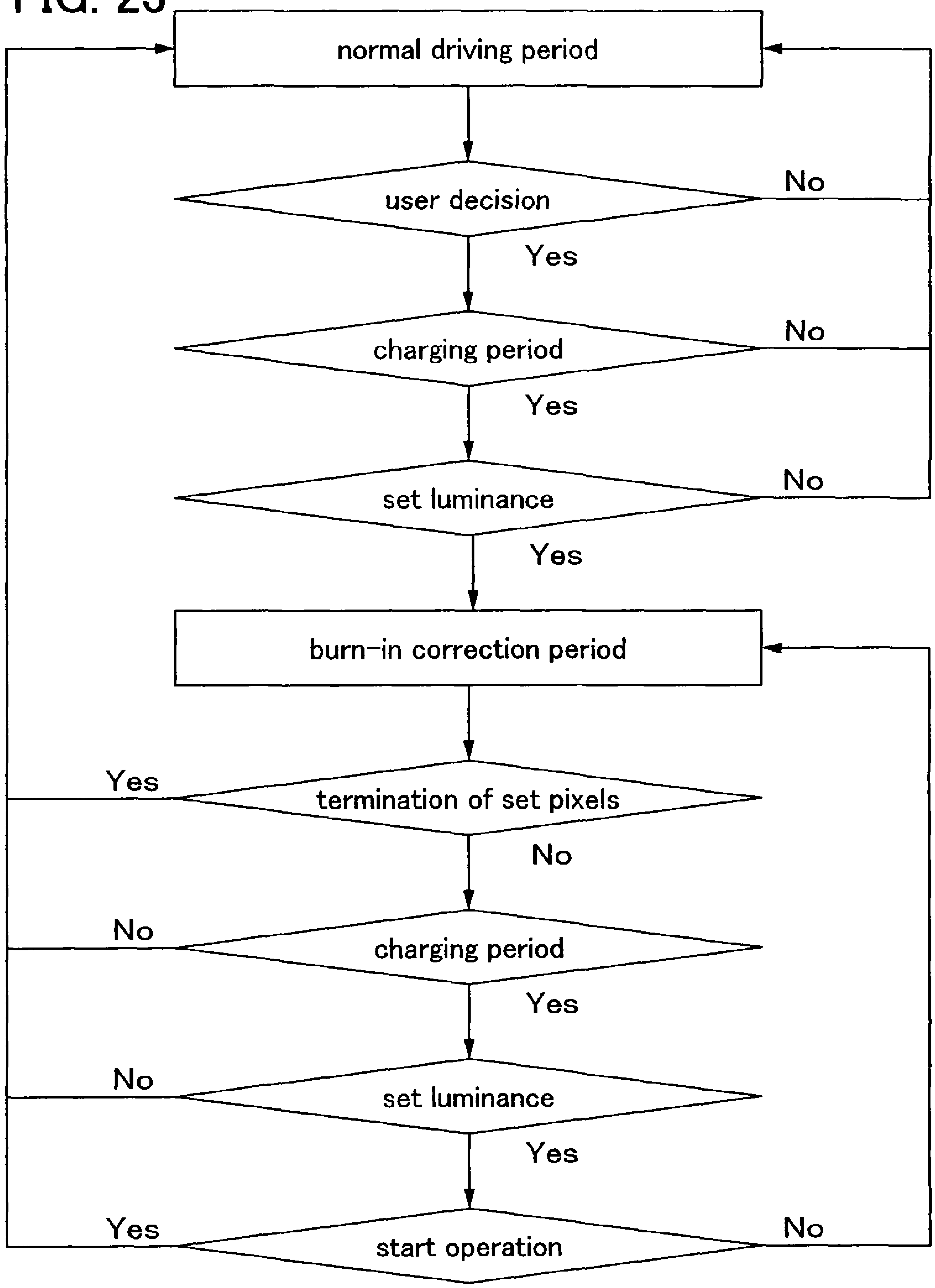

normal driving period
user decision
No
Yes
charging period
No
Yes
set luminance
No
Yes
burn-in correction period
Yes
termination of set pixels
No
No
charging period
Yes
No
set luminance
Yes
Yes
start operation
No

FIG. 24A

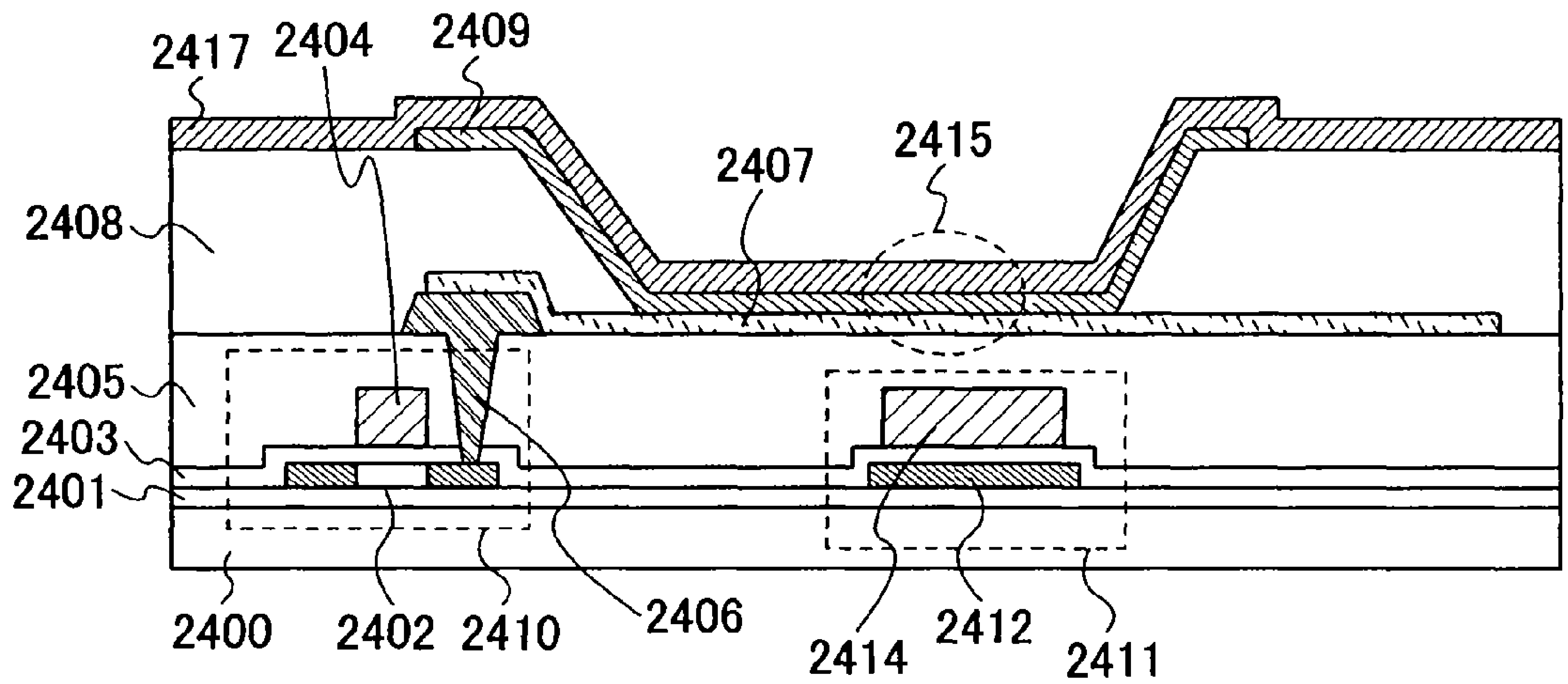


FIG. 24B

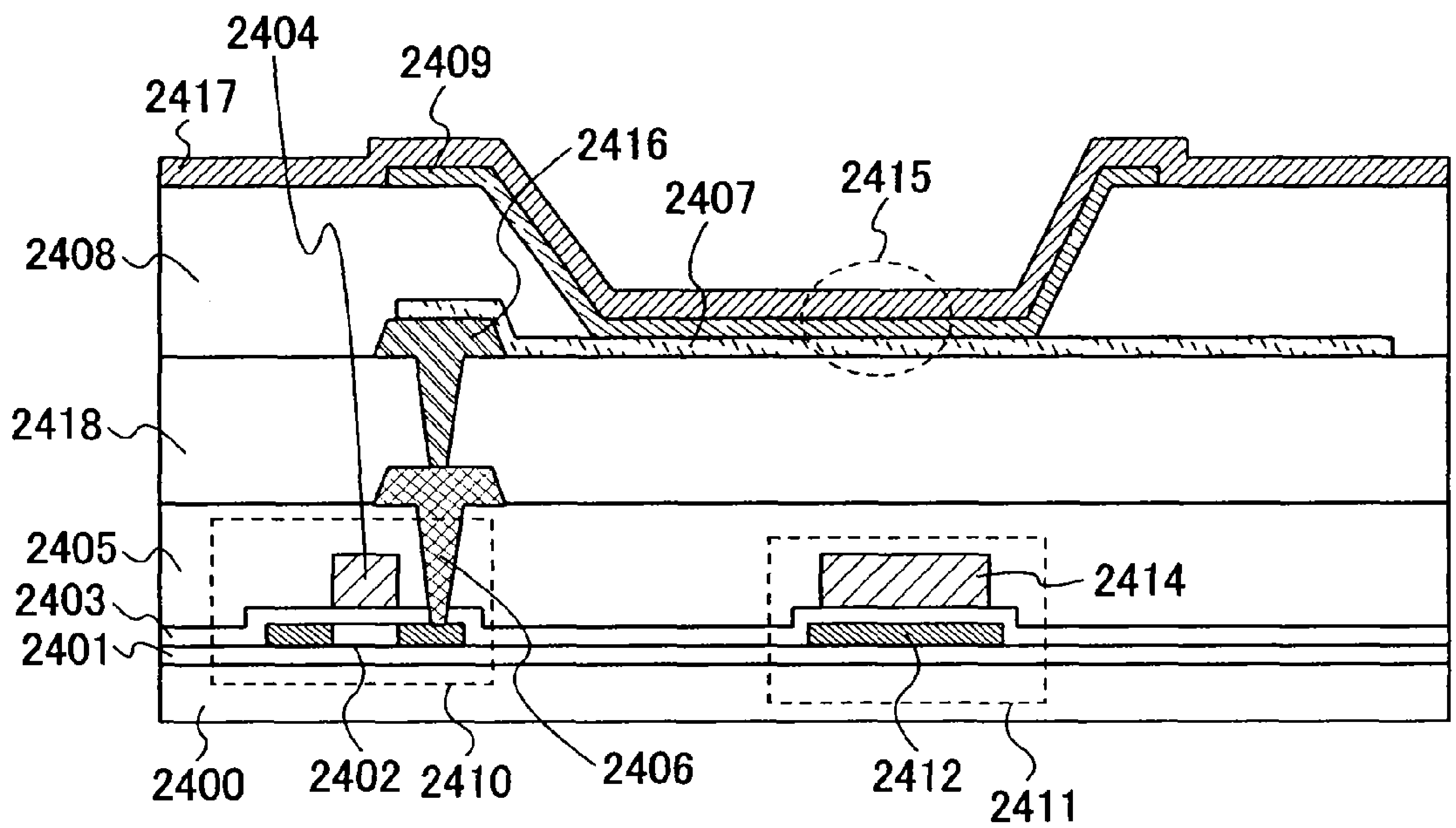


FIG. 25A

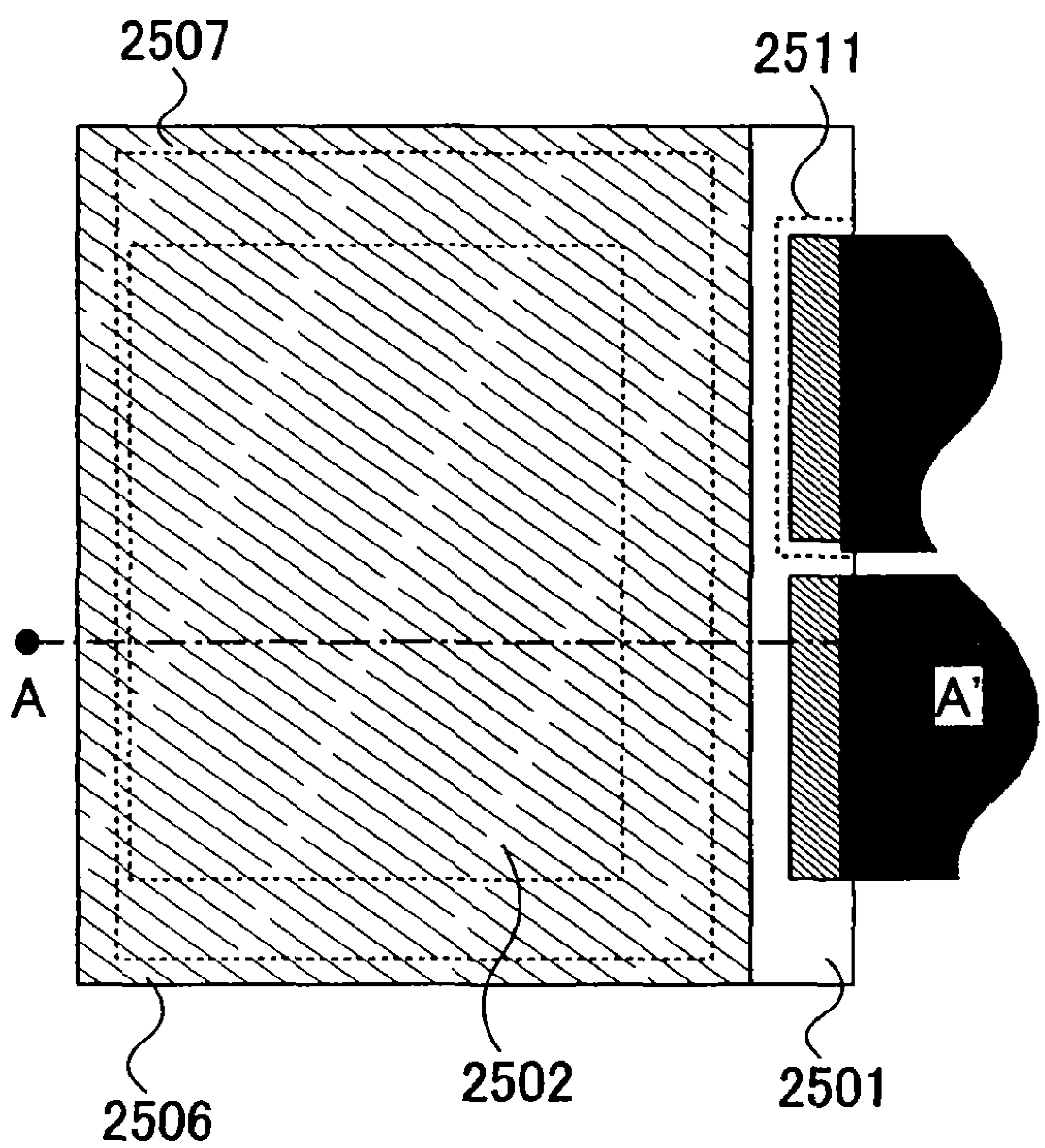


FIG. 25B

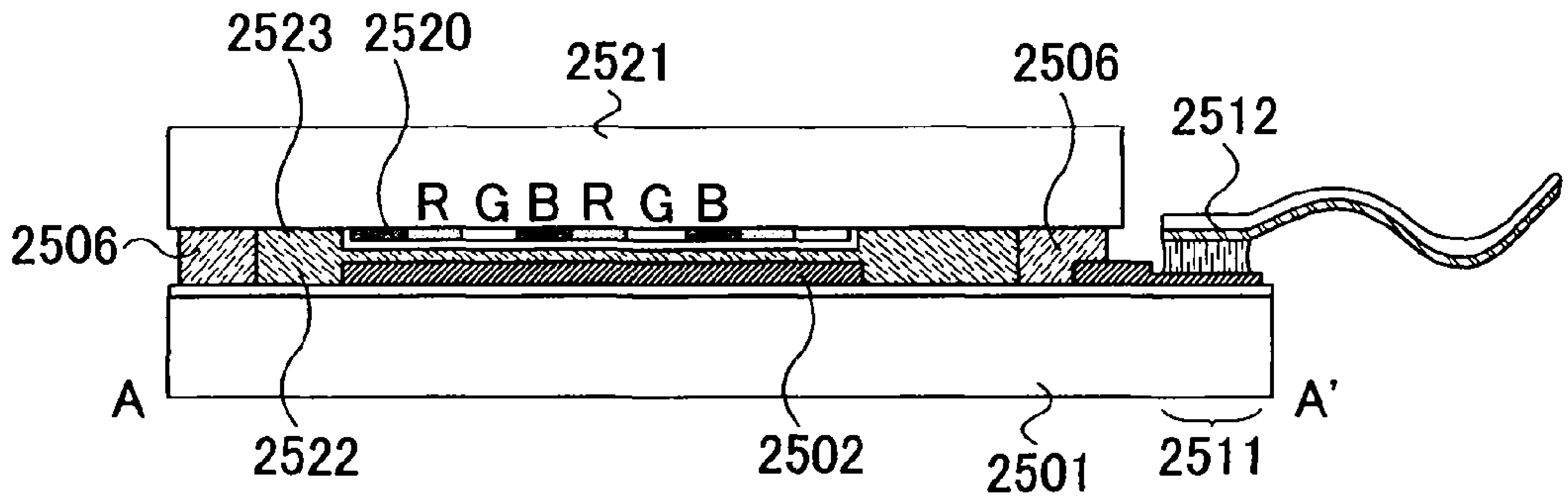


FIG. 25C

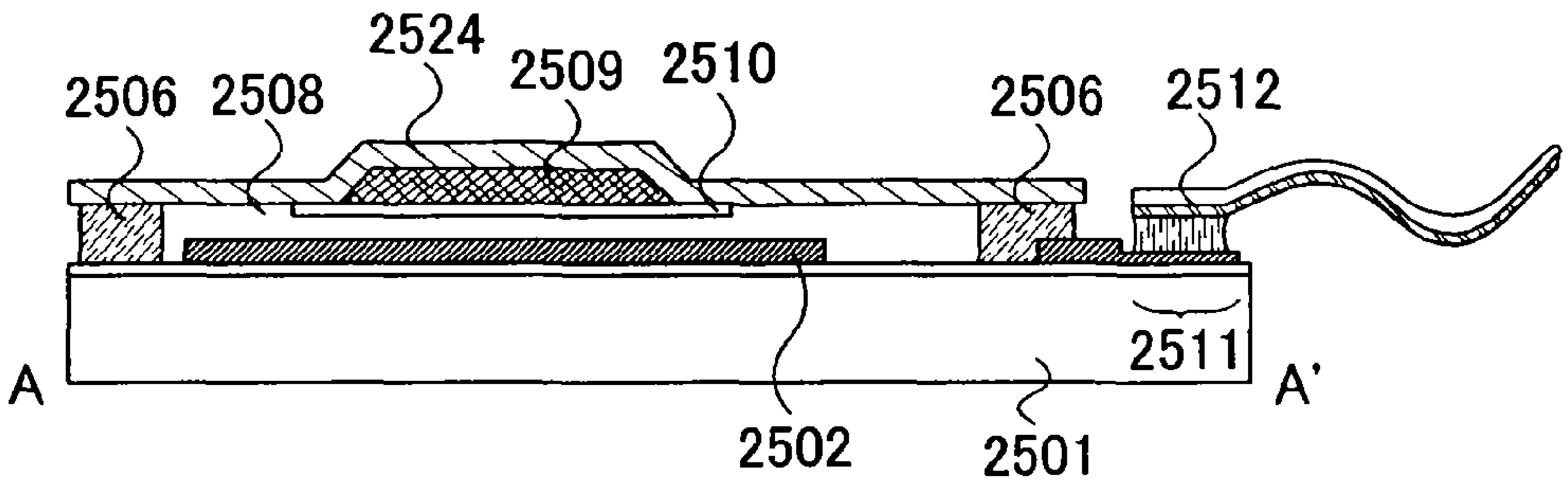


FIG. 26

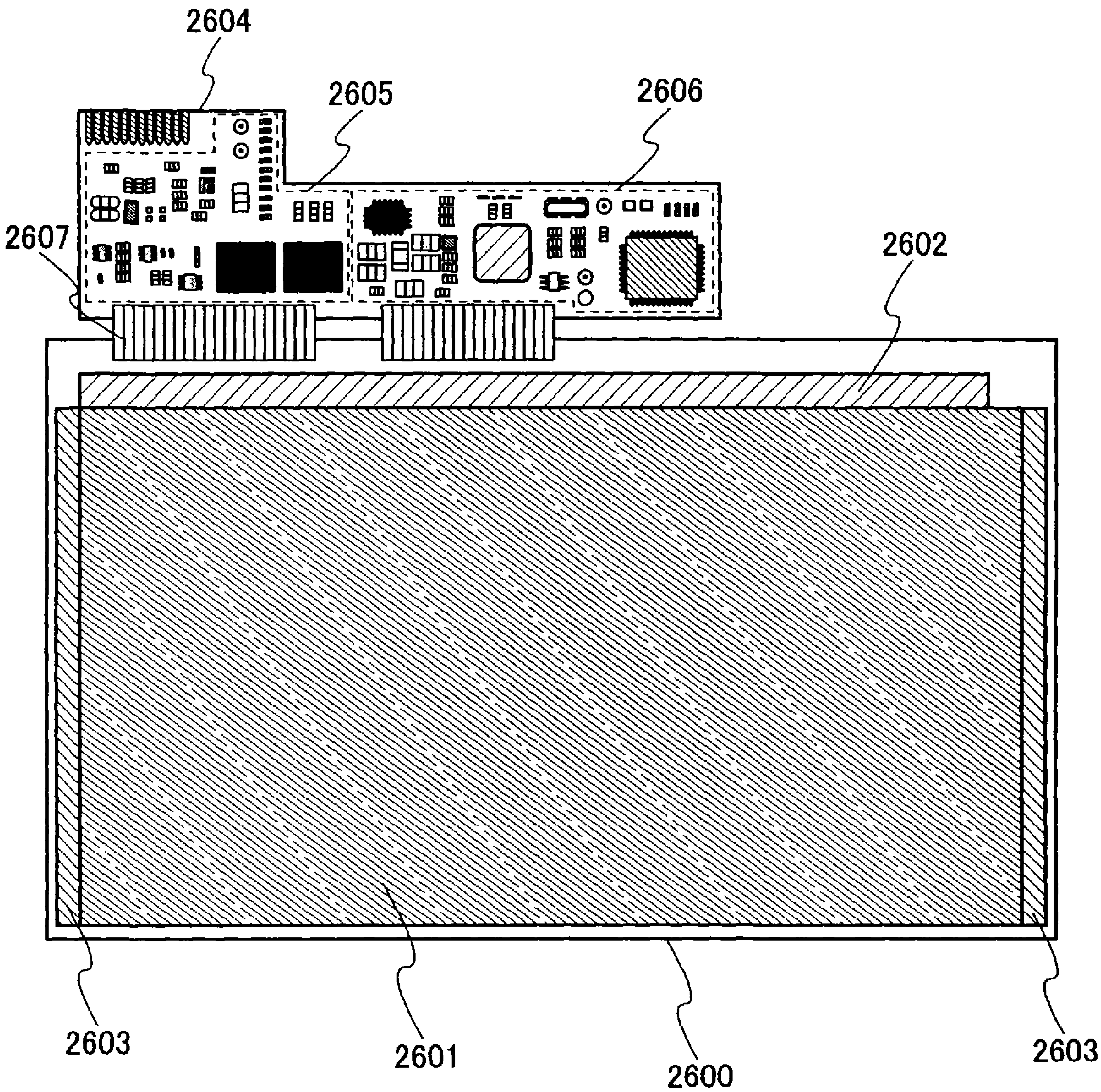


FIG. 27A

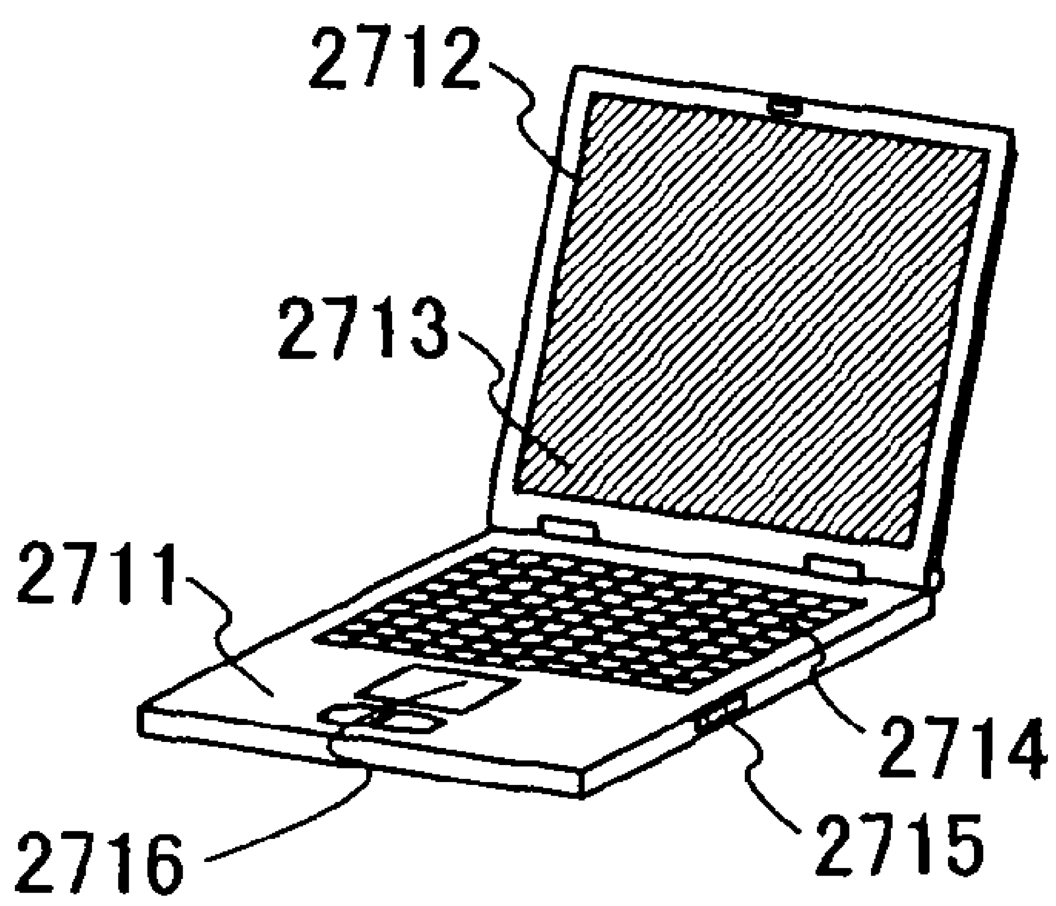


FIG. 27B

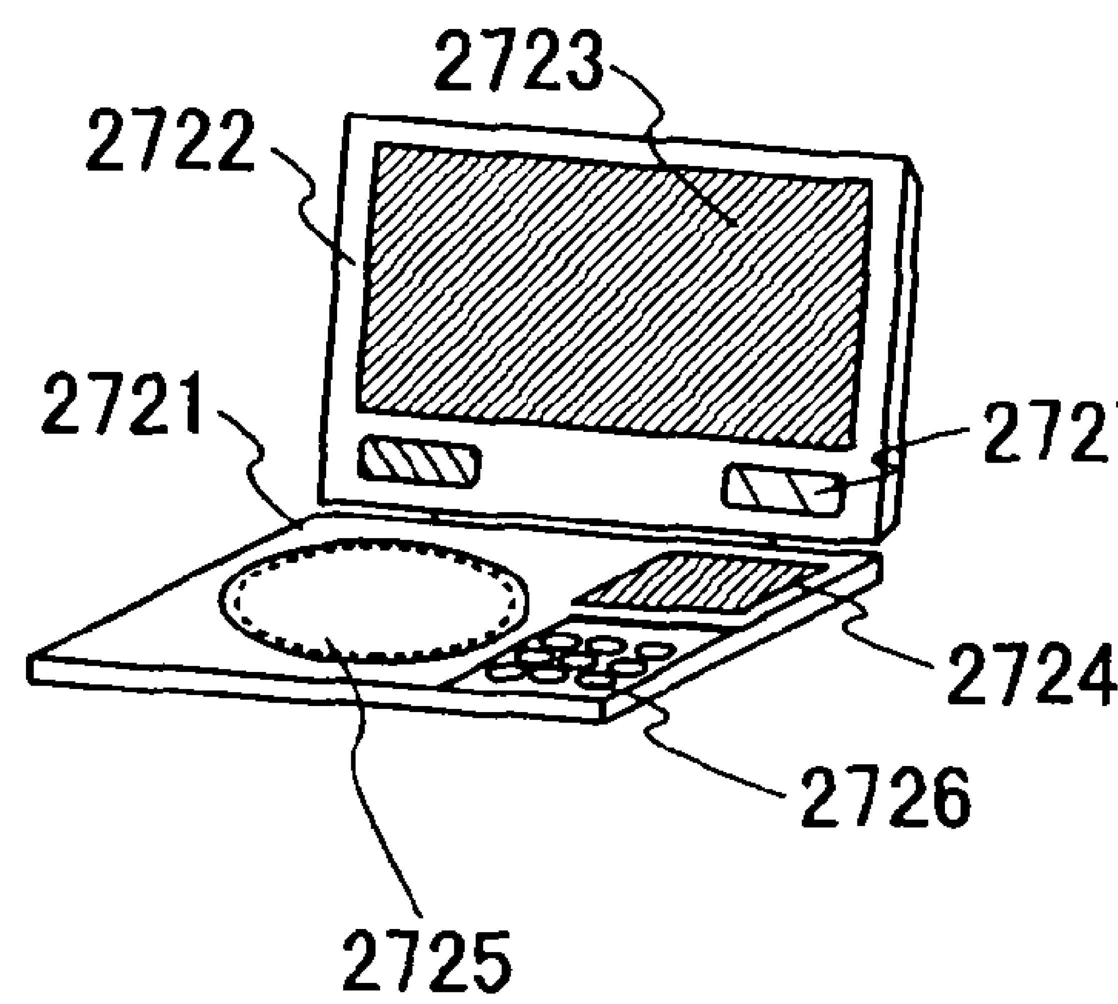


FIG. 27C

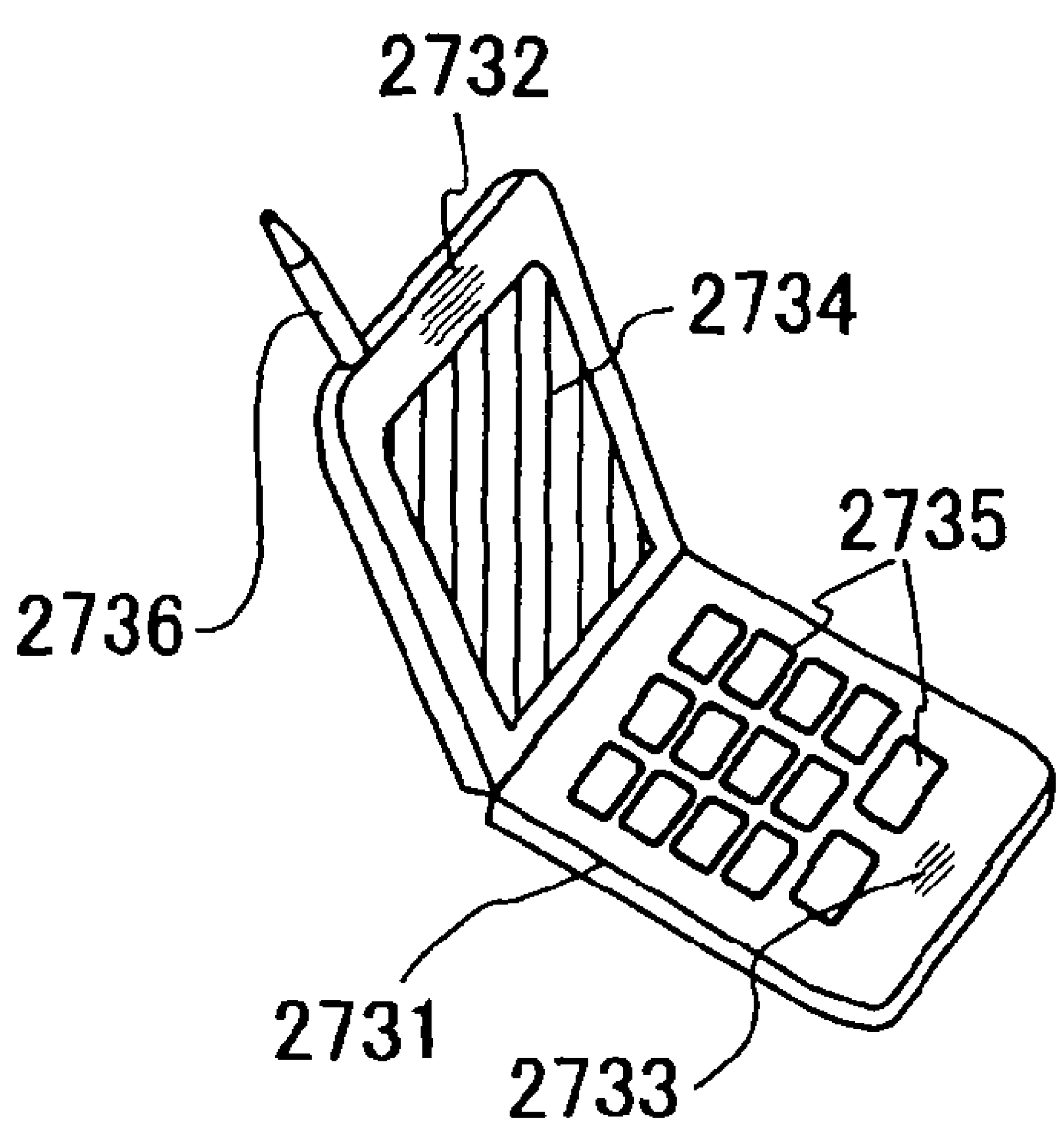
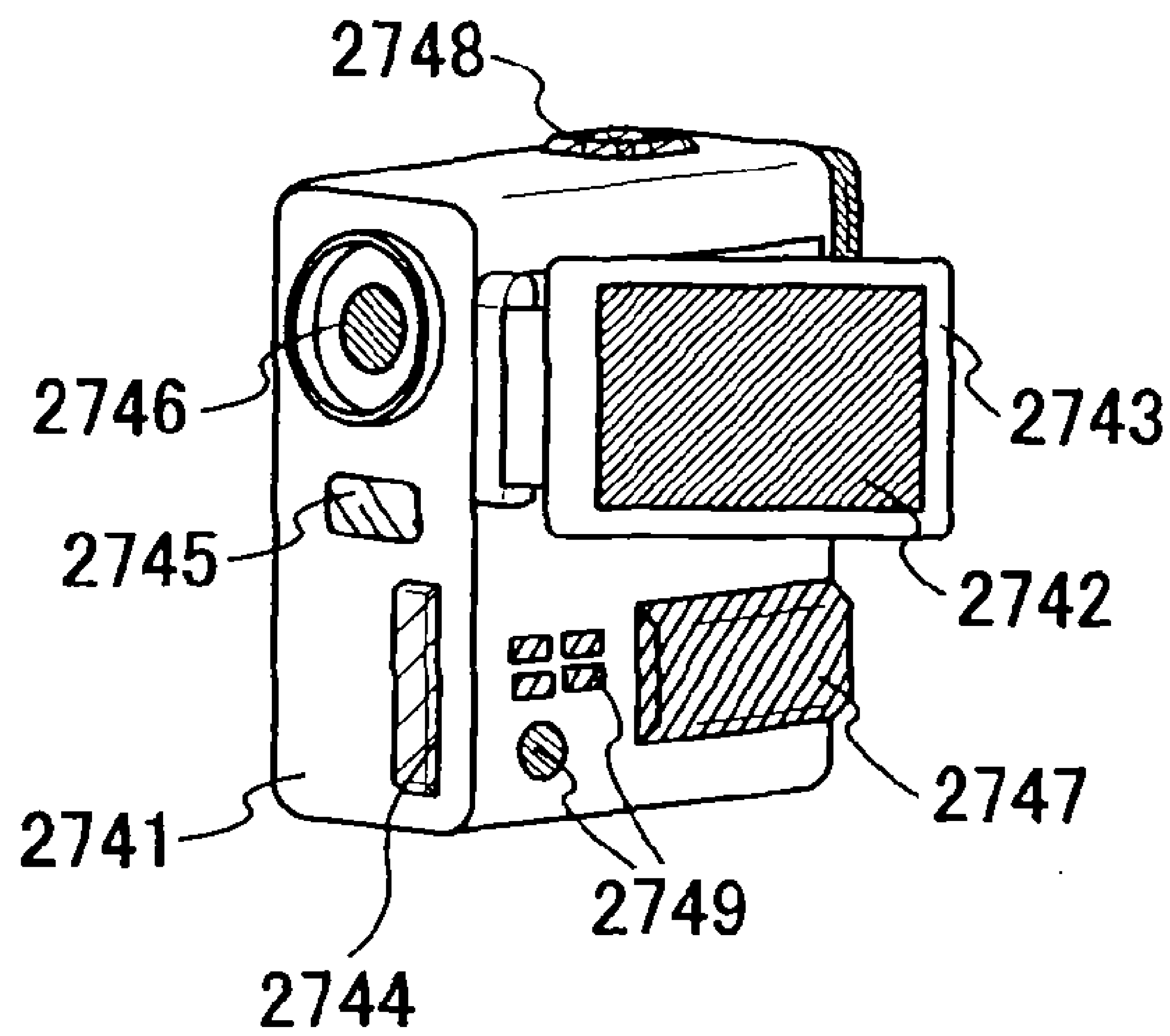


FIG. 27D



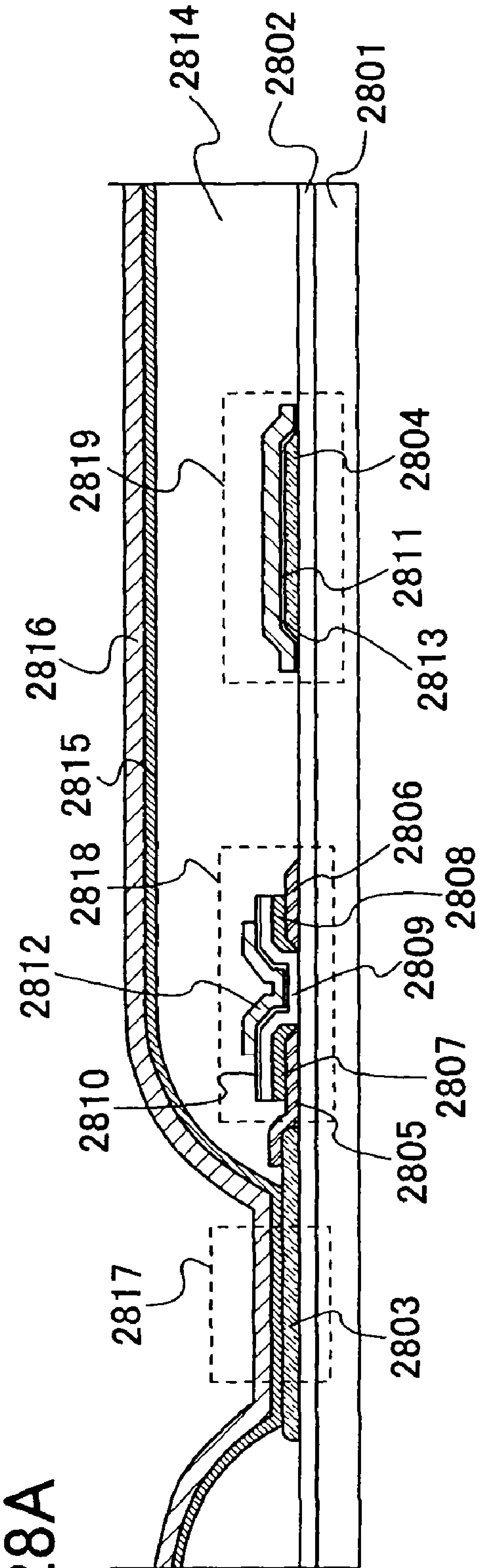


FIG. 28A

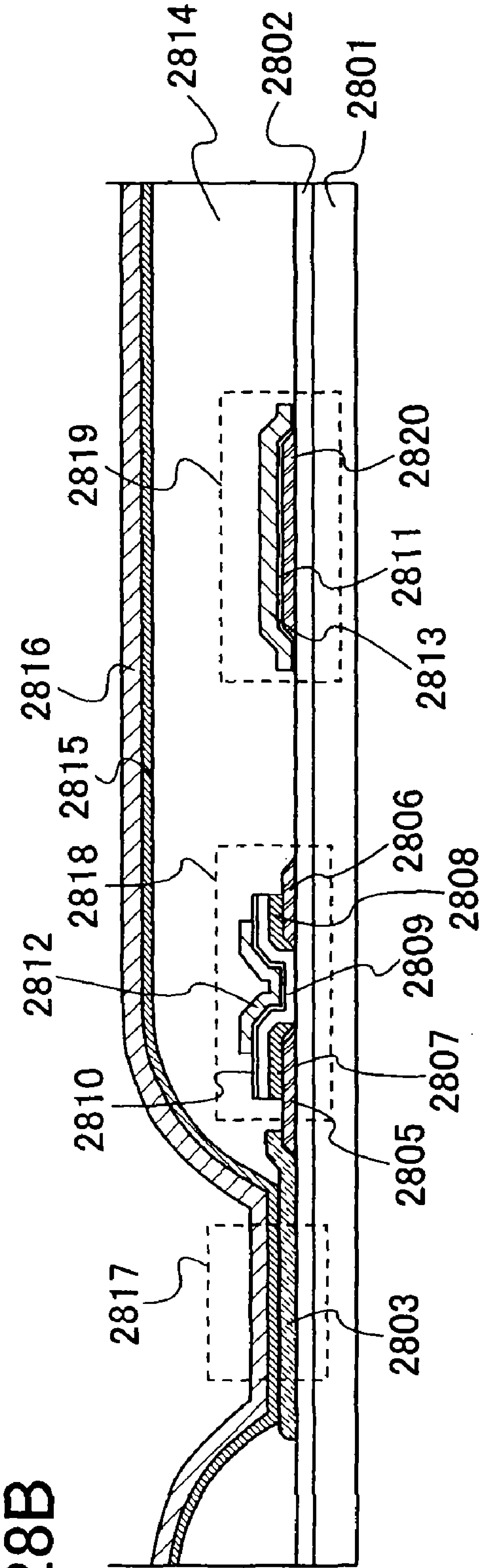


FIG. 28B

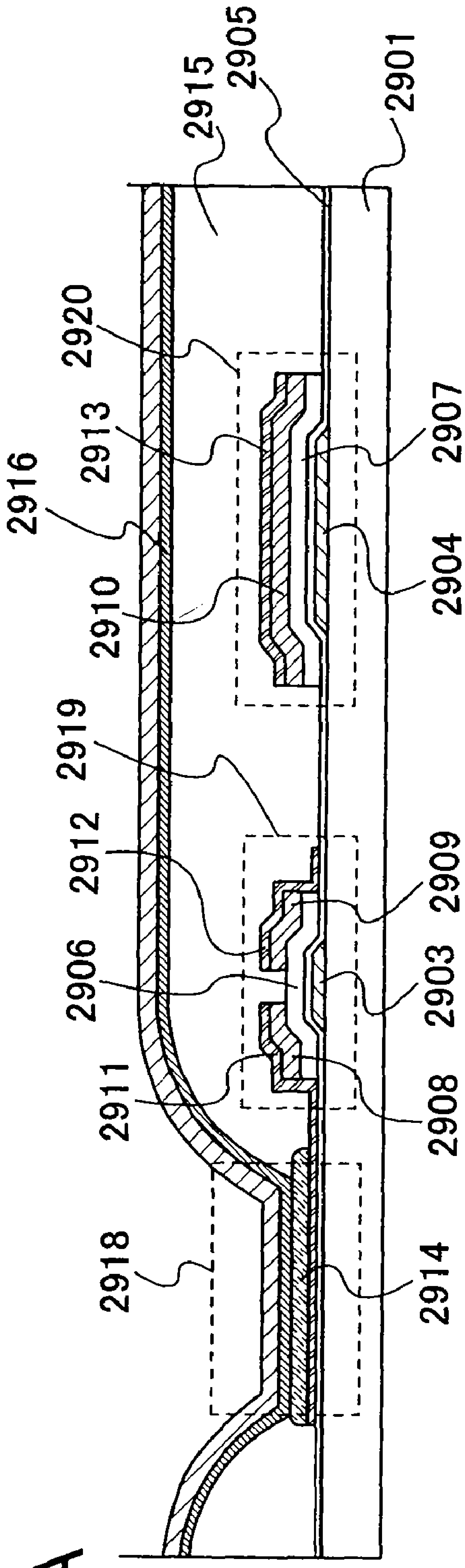


FIG. 29A

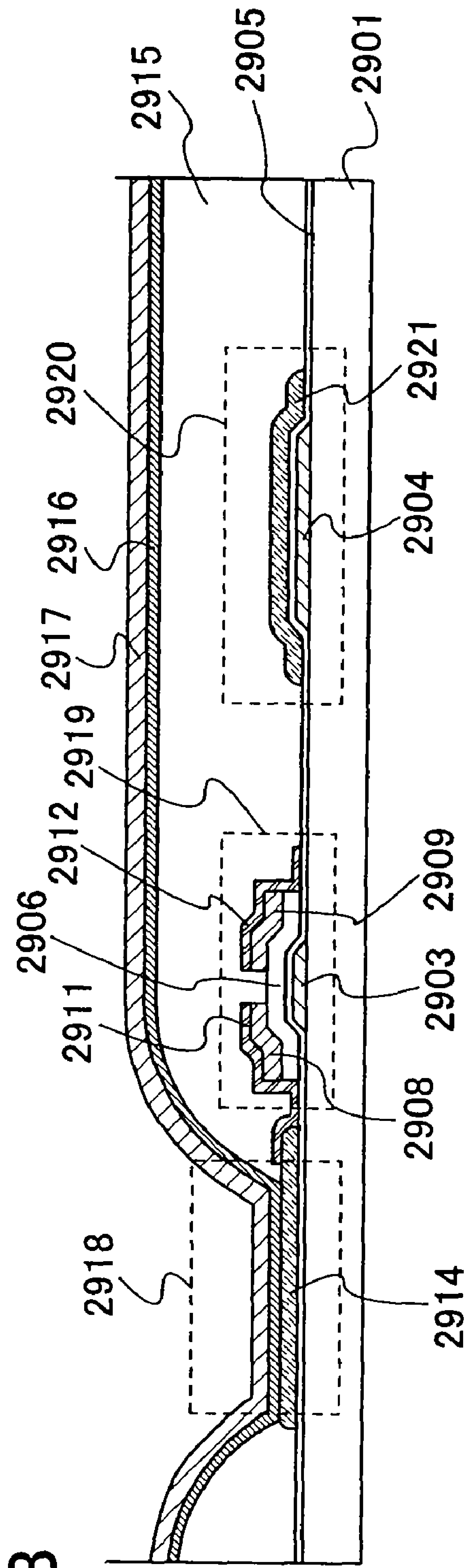


FIG. 29B

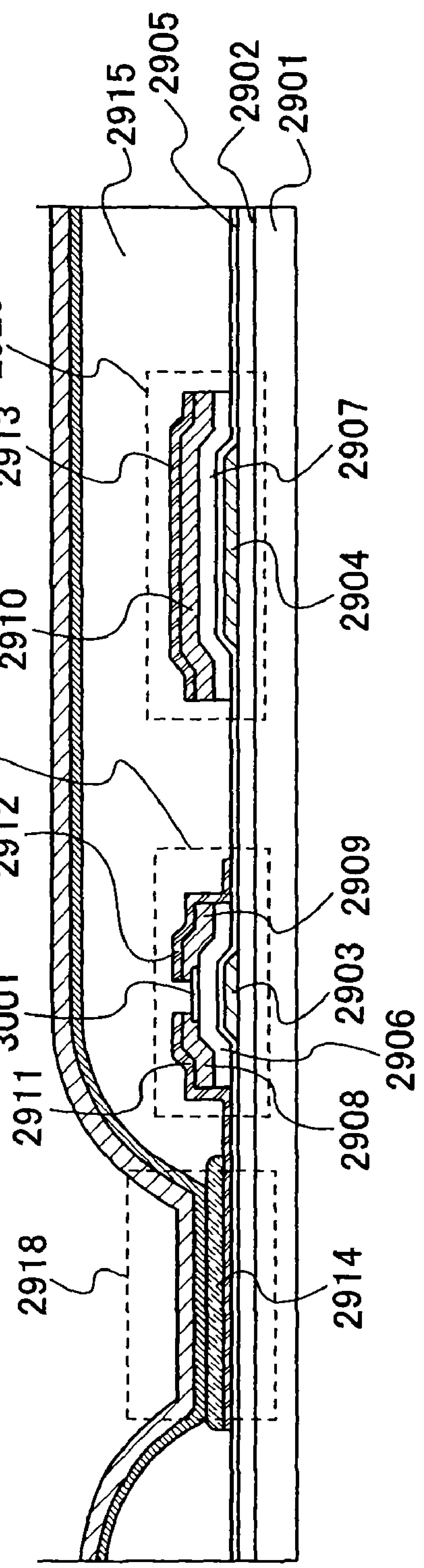


FIG. 30A

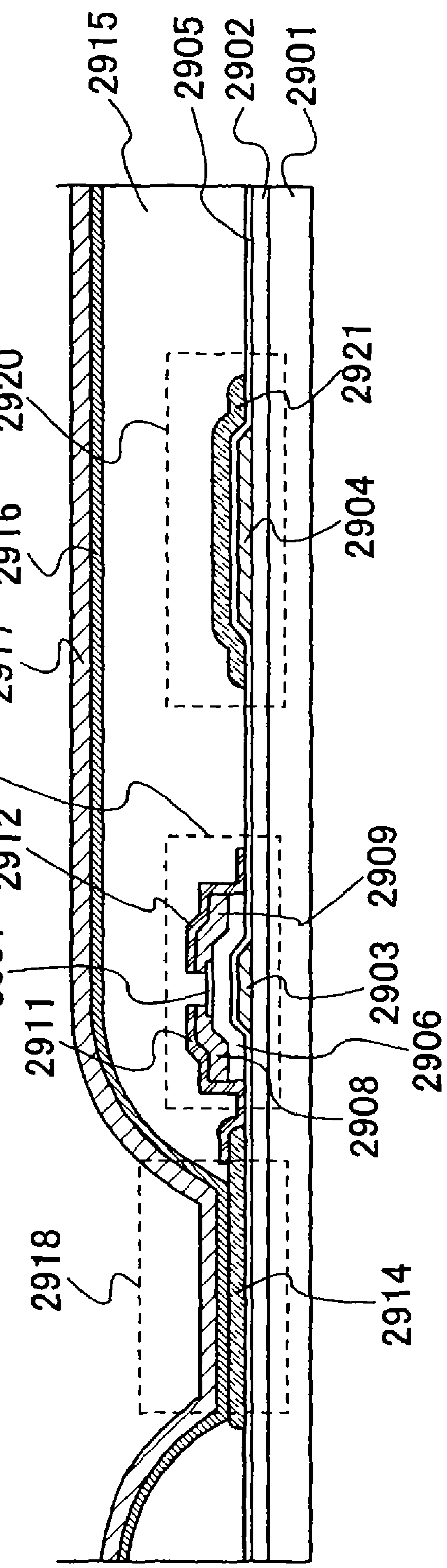


FIG. 30B

FIG. 31A

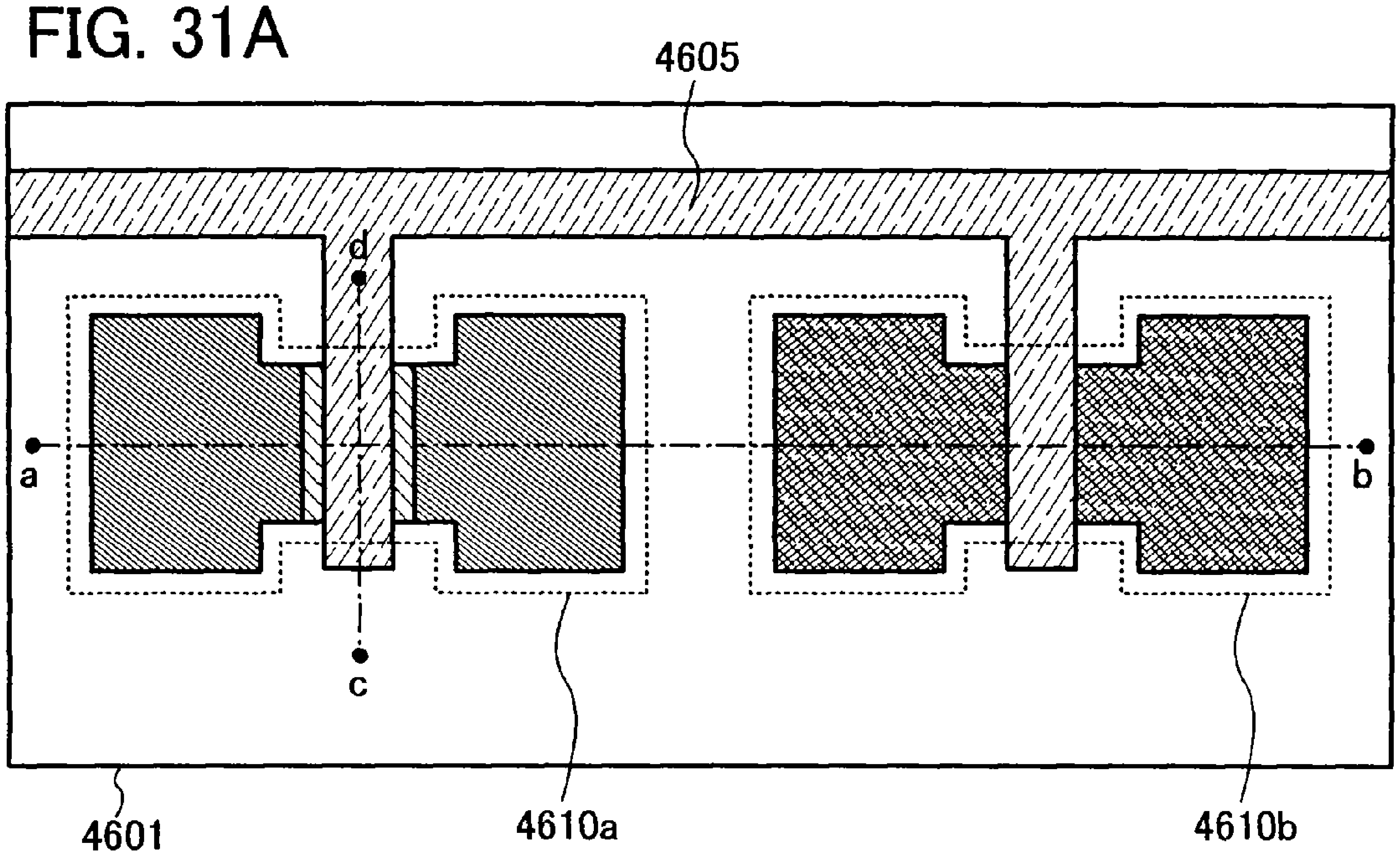


FIG. 31B

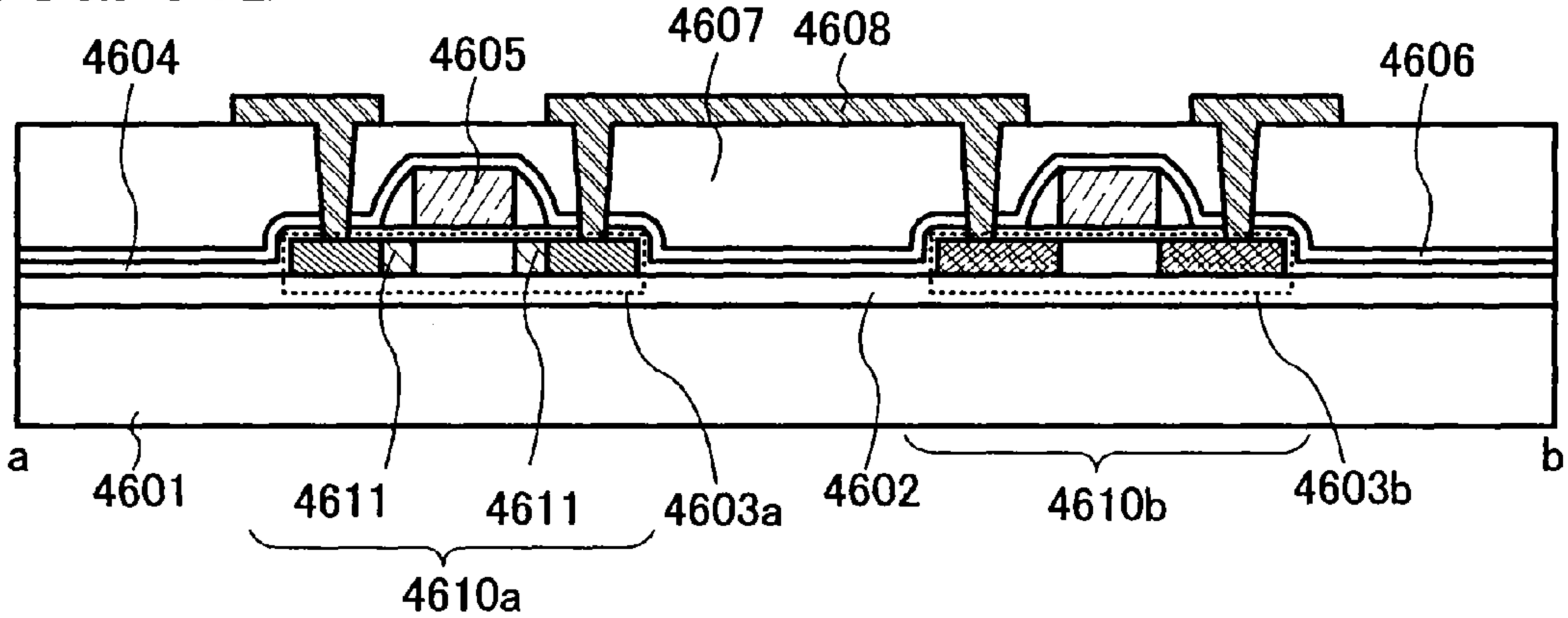
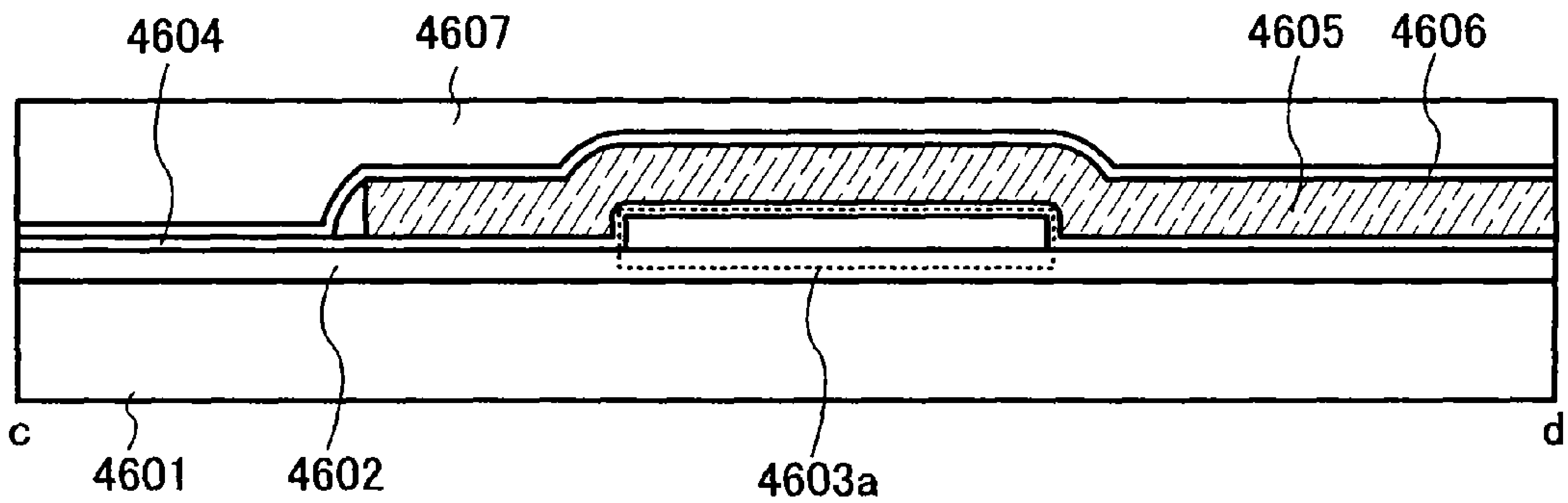


FIG. 31C



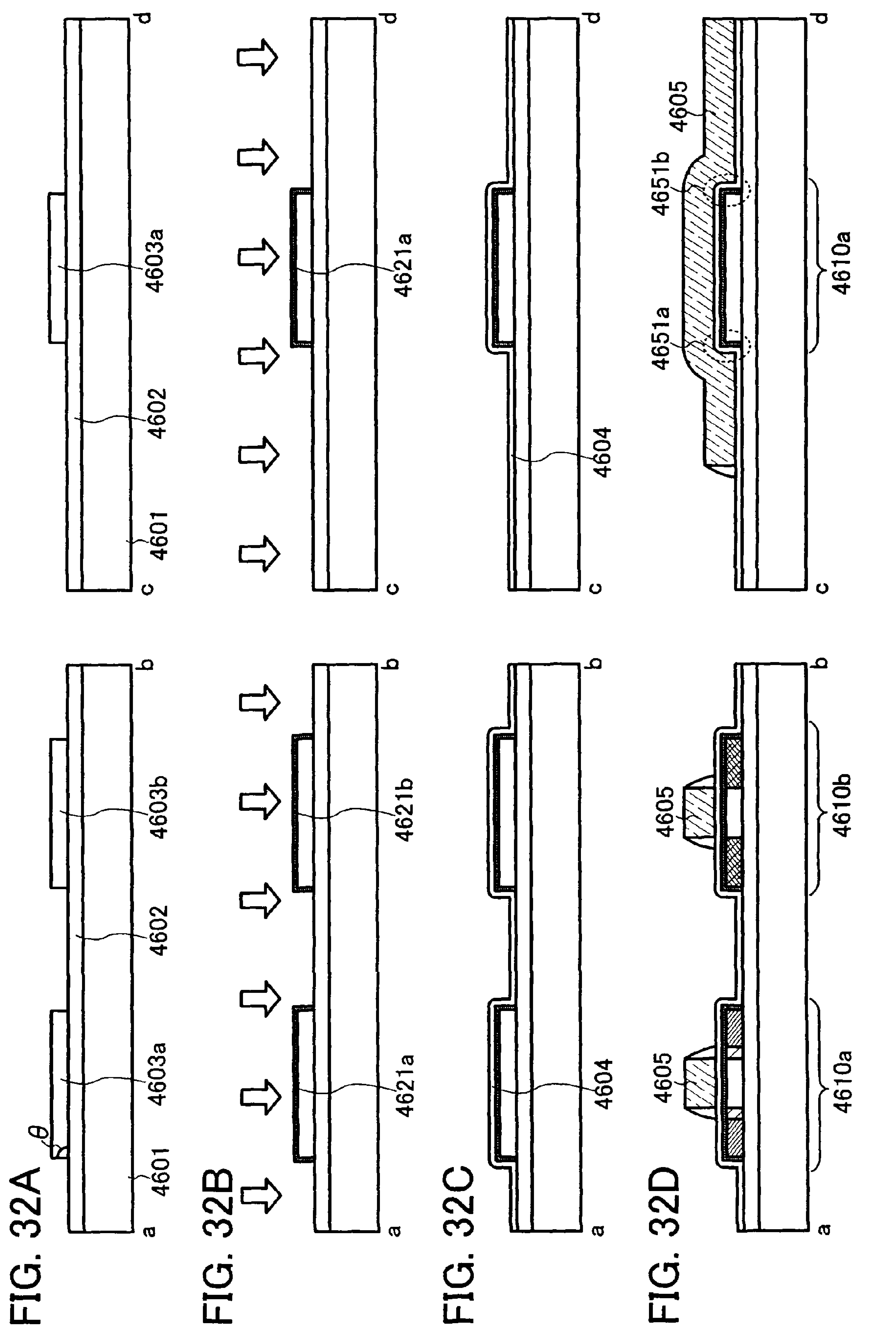


FIG. 32A

FIG. 32B

FIG. 32C

FIG. 32D

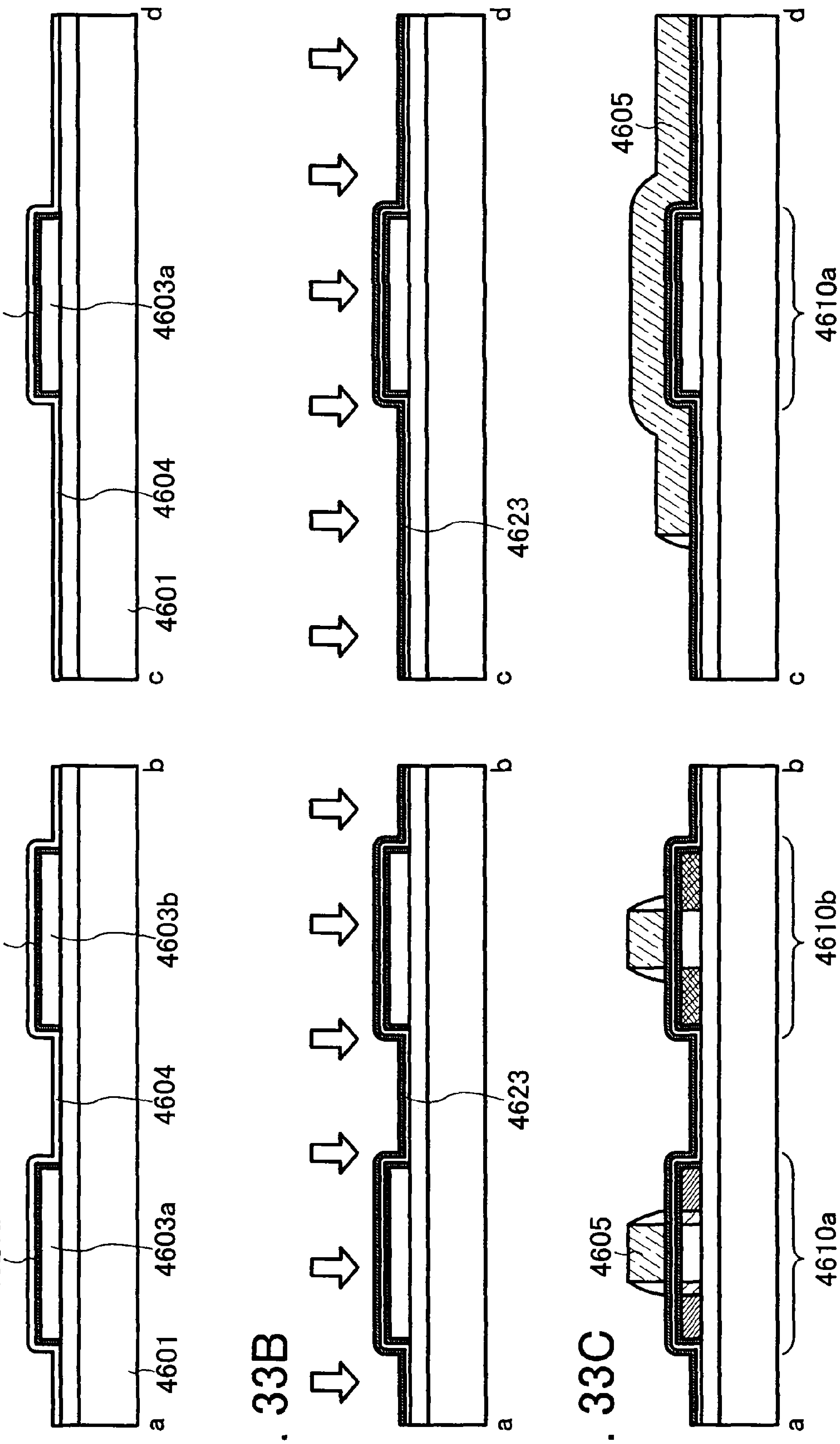


FIG. 33A

FIG. 33B

FIG. 33C

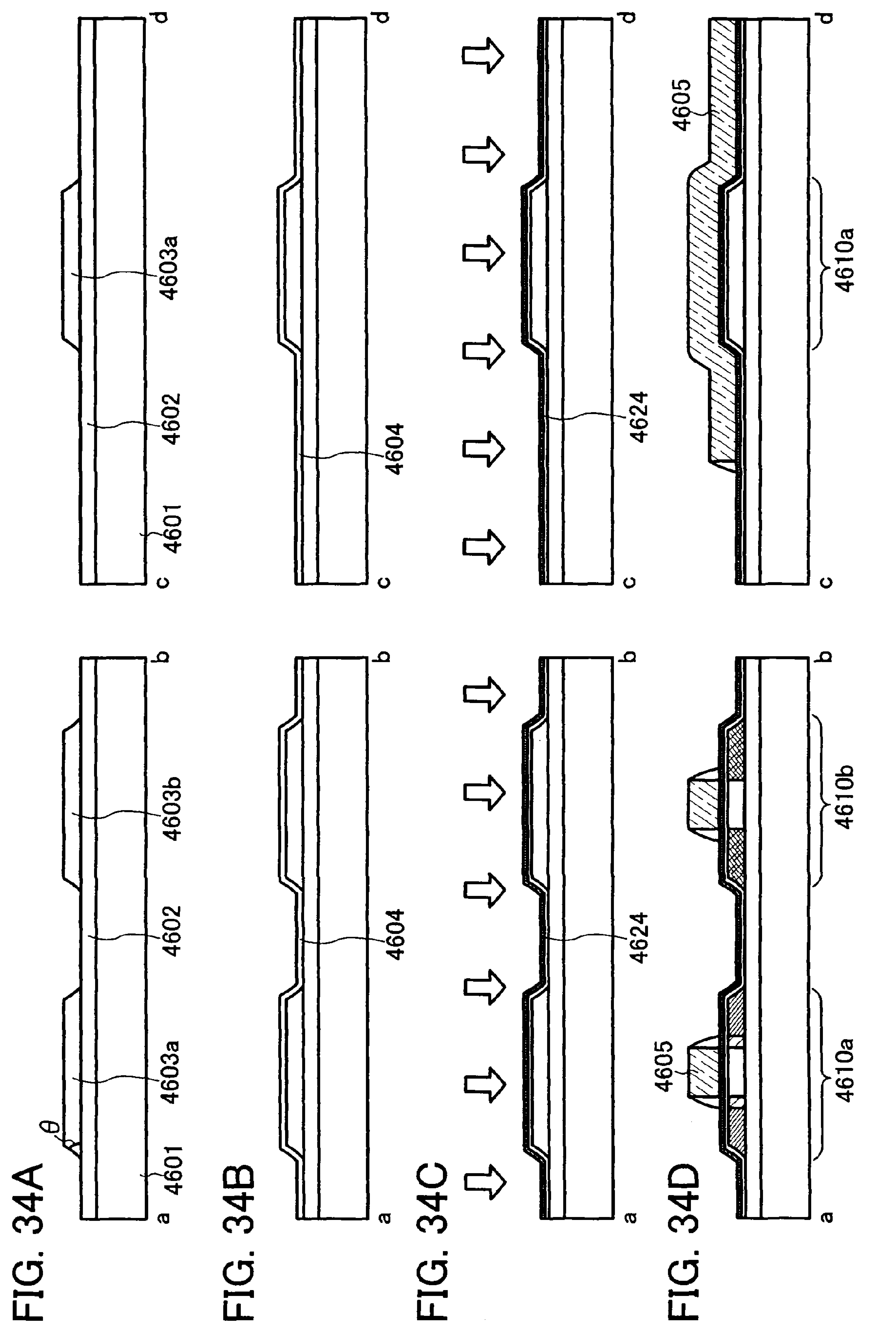


FIG. 34A
FIG. 34B
FIG. 34C
FIG. 34D
a
b
c
d
θ
4601
4602
4603a
4603b
4604
4624
4605
4610a
4610b

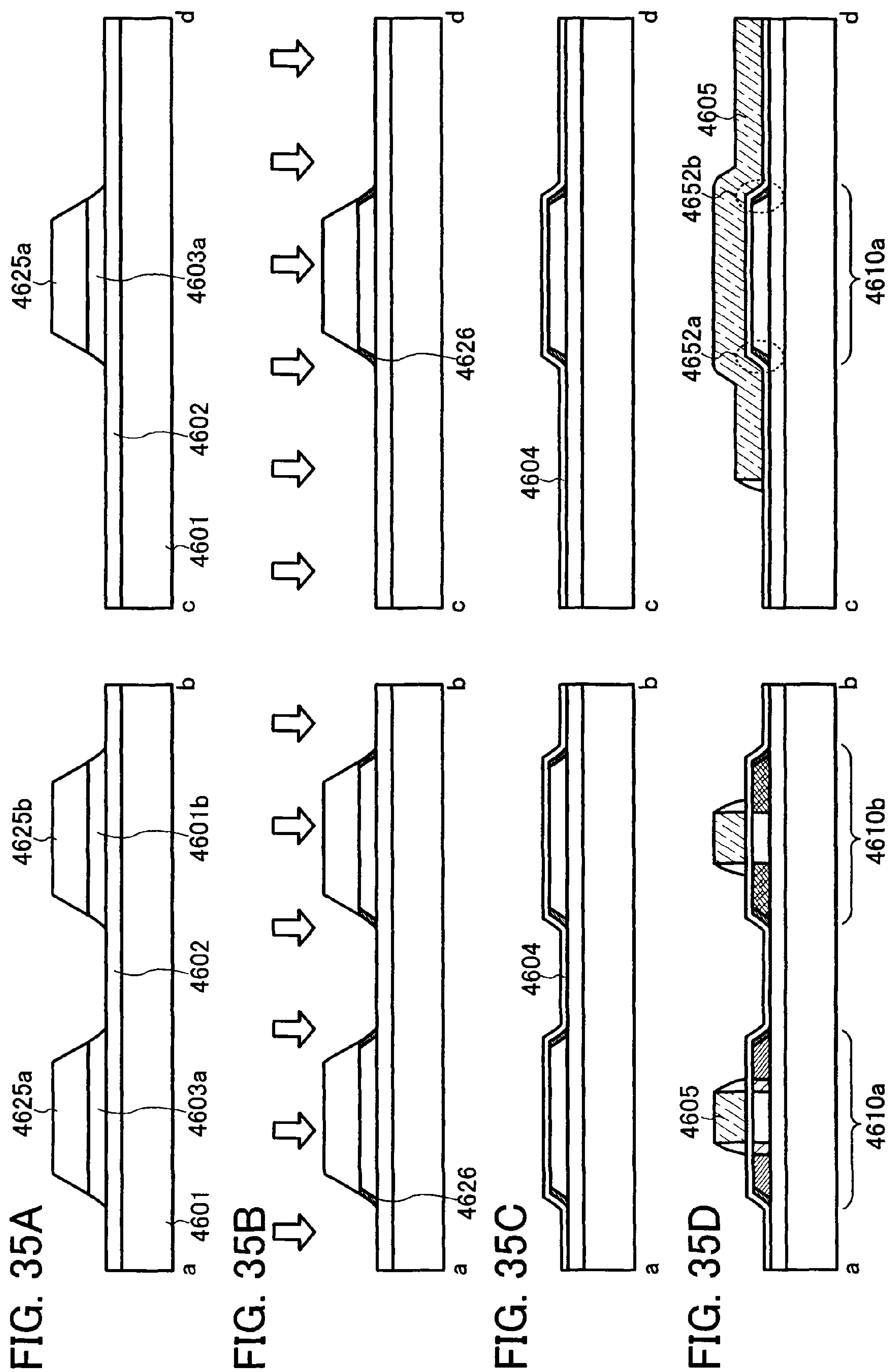


FIG. 35A

FIG. 35B

FIG. 35C

FIG. 35D

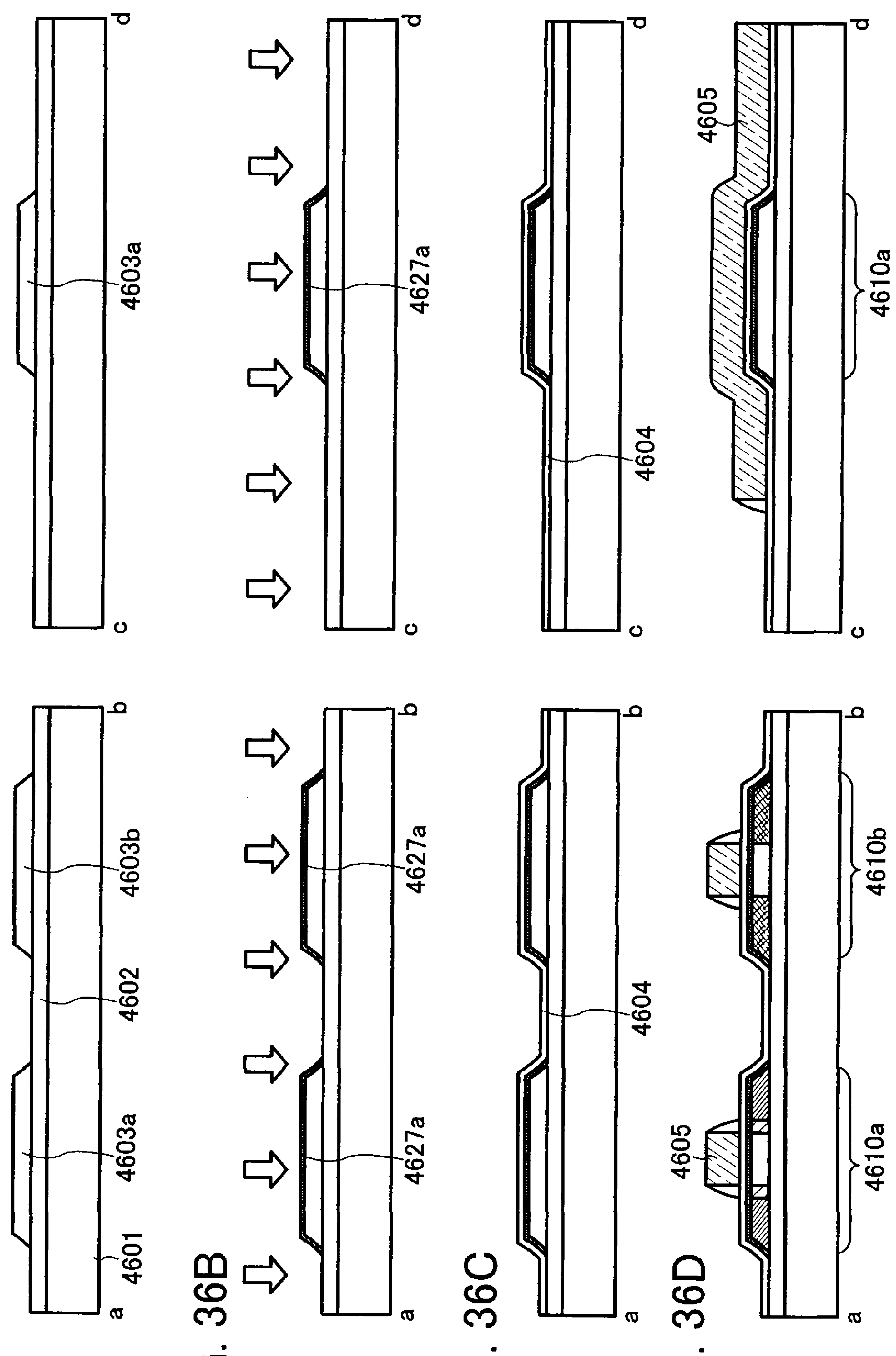


FIG. 36A

FIG. 36B

FIG. 36C

FIG. 36D

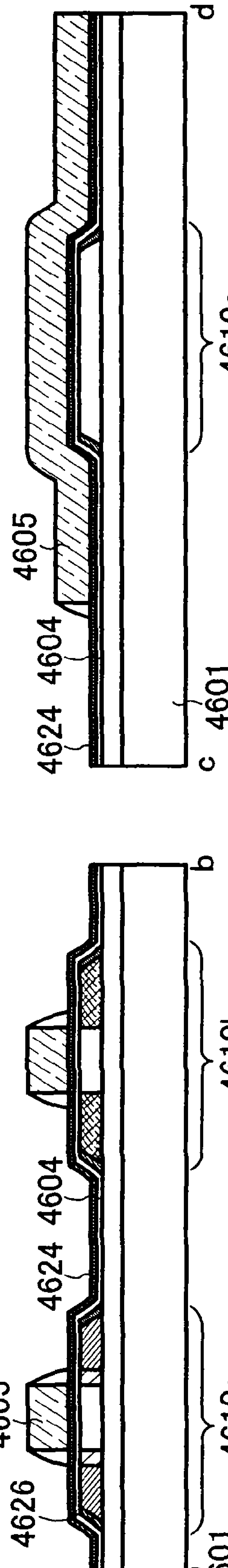


FIG. 37A

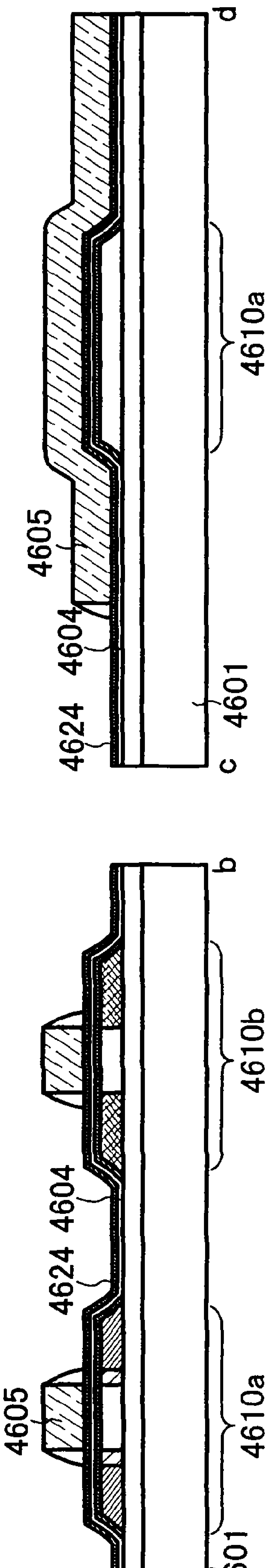


FIG. 37B

FIG. 38A

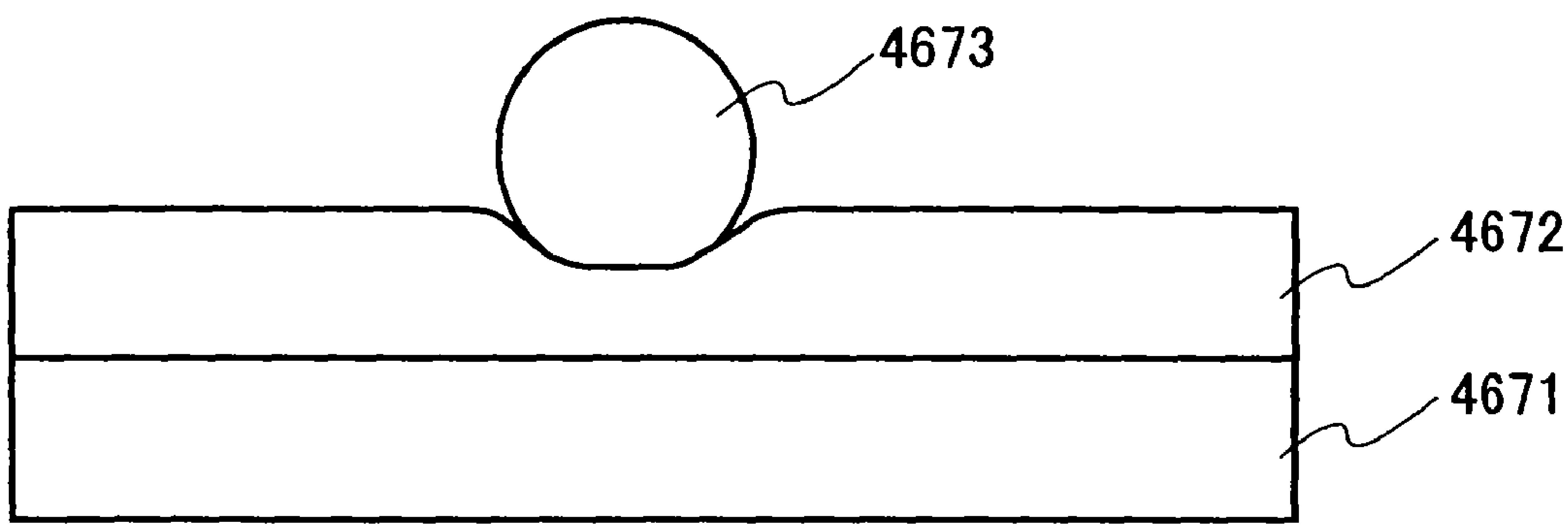


FIG. 38B

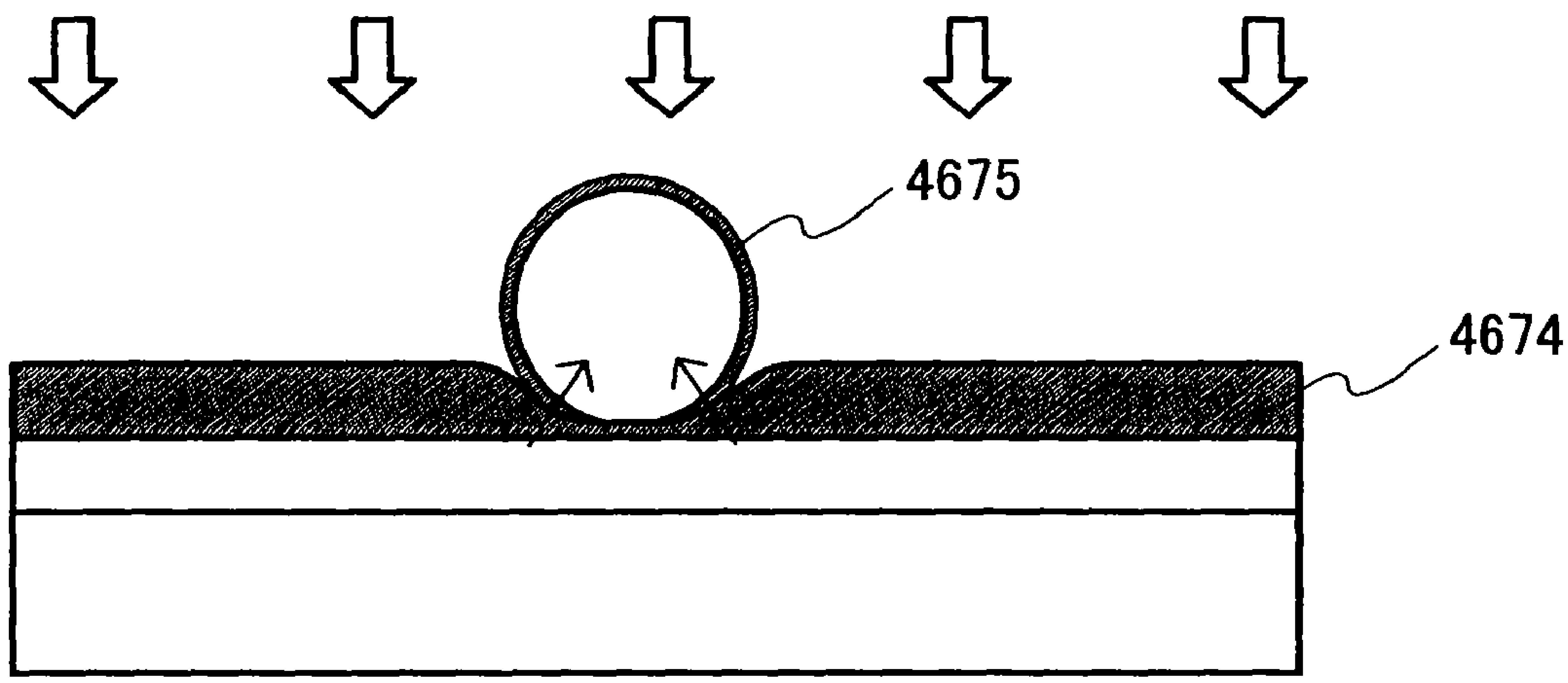


FIG. 39

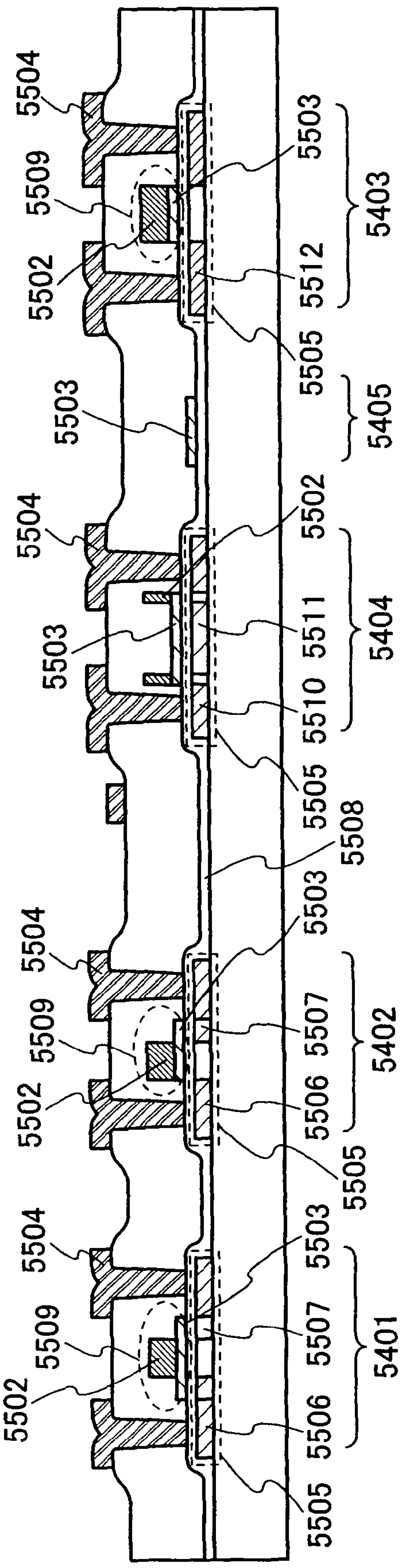

5504
5509
5503
5502
5512
5505
5403
5503
5405
5504
5502
5503
5511
5510
5505
5404
5508
5504
5503
5509
5507
5502
5506
5505
5402
5504
5503
5509
5507
5502
5506
5505
5401

FIG. 40A

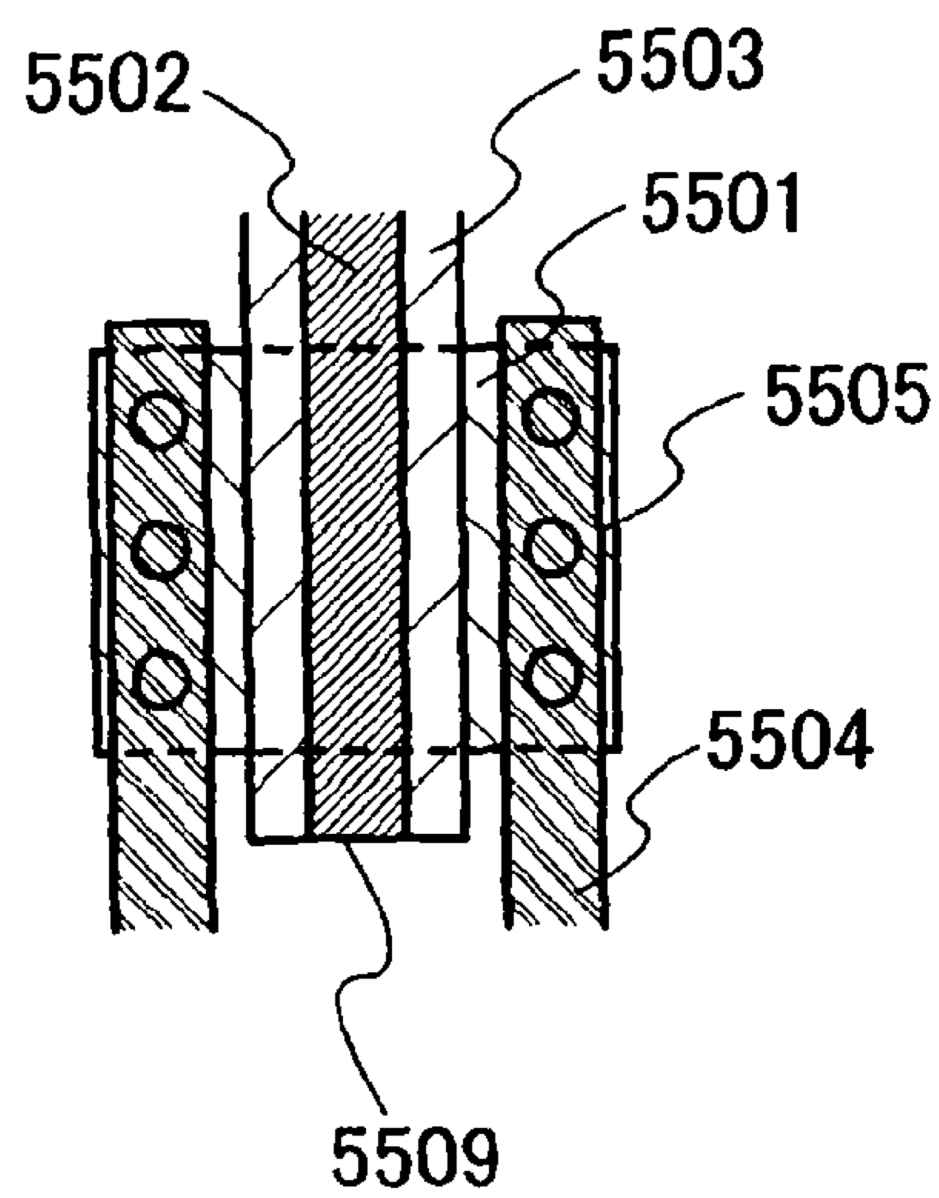


FIG. 40B

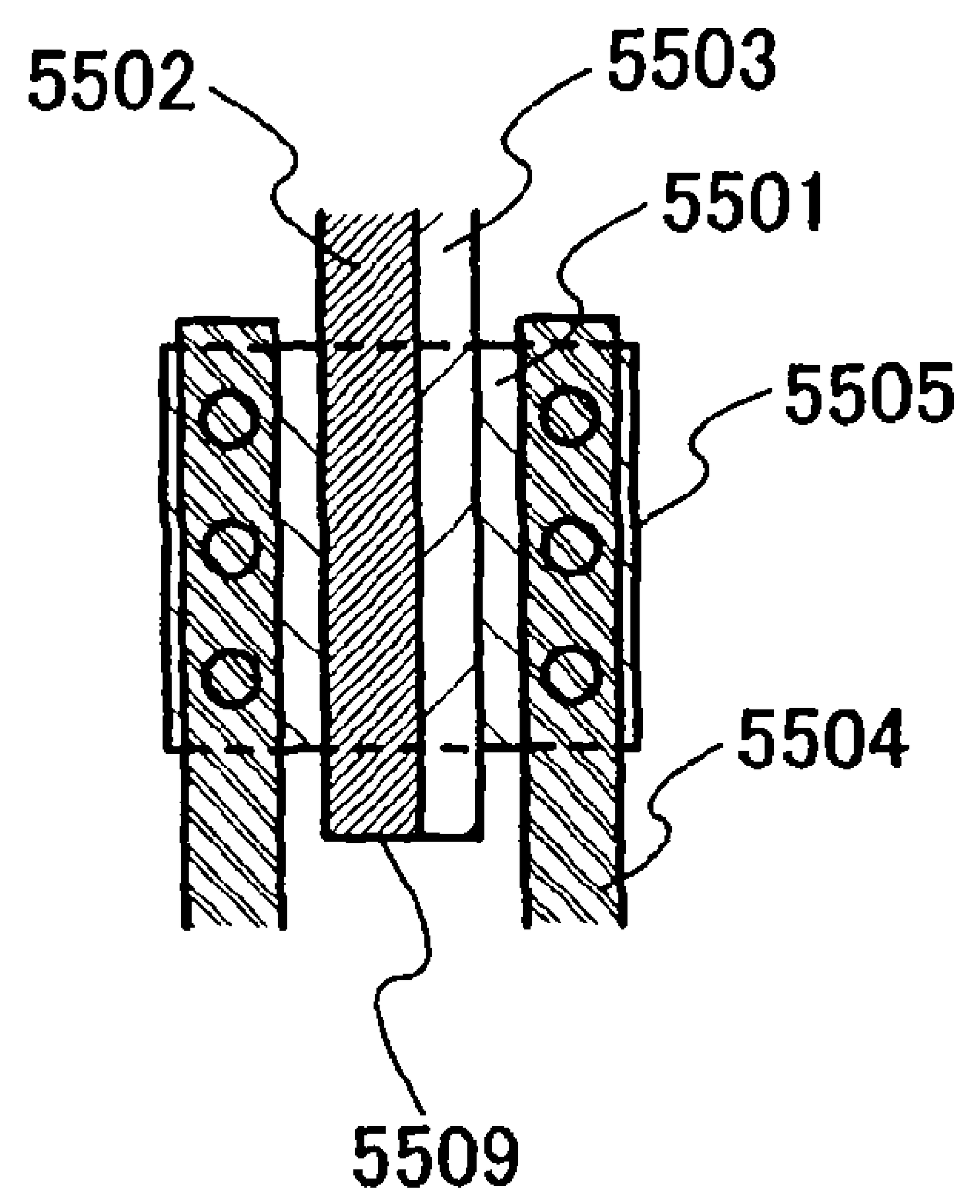


FIG. 40C

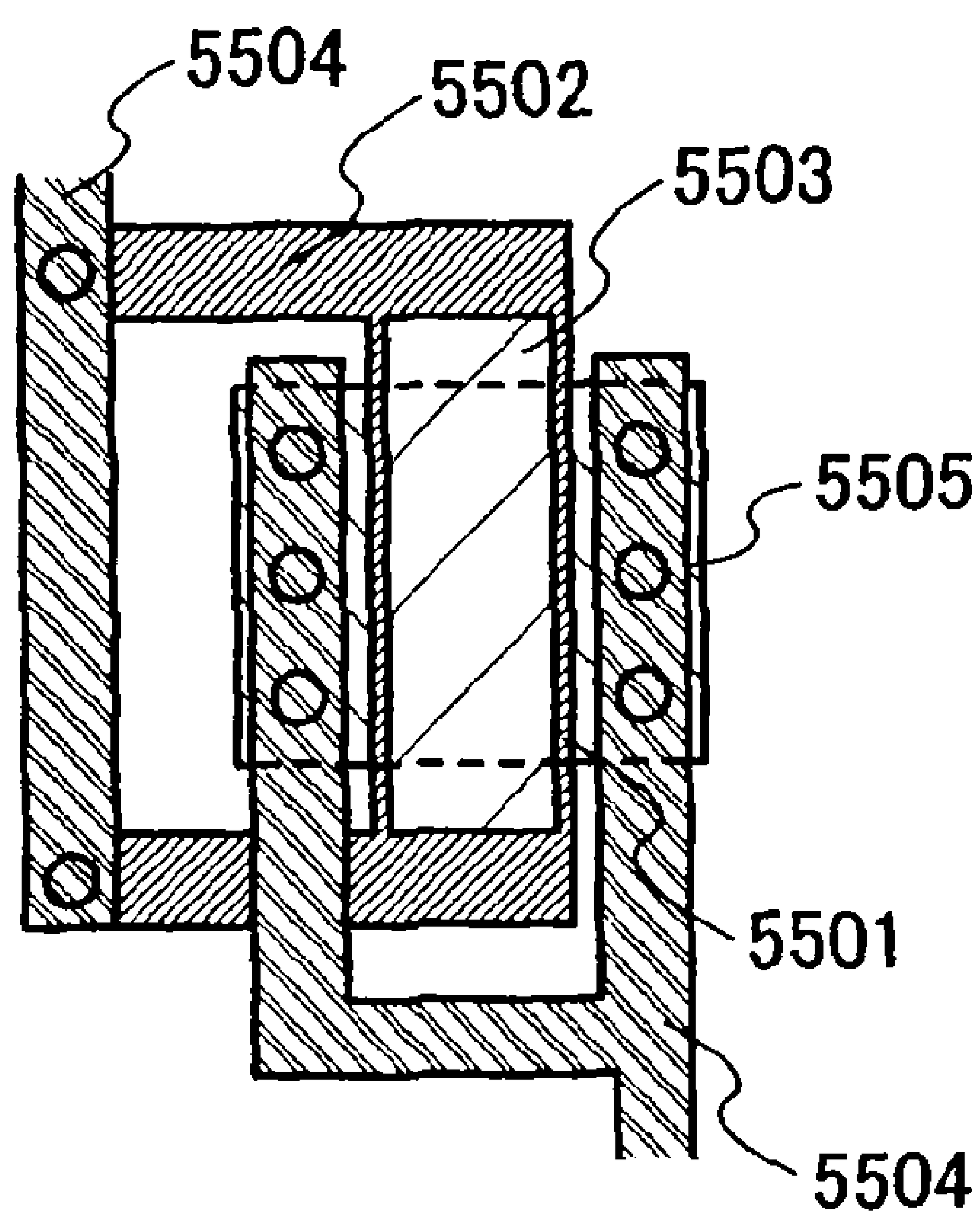


FIG. 40D

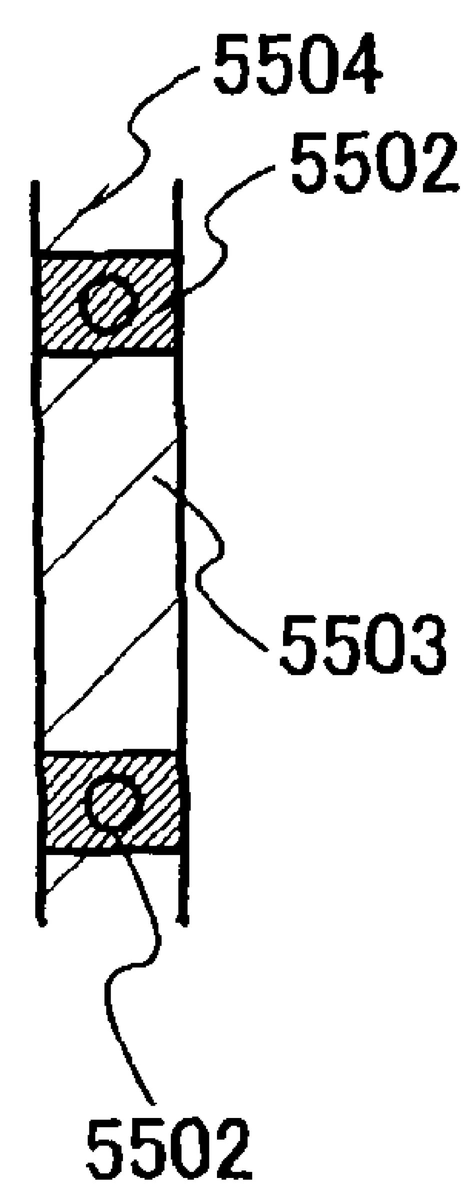


FIG. 40E

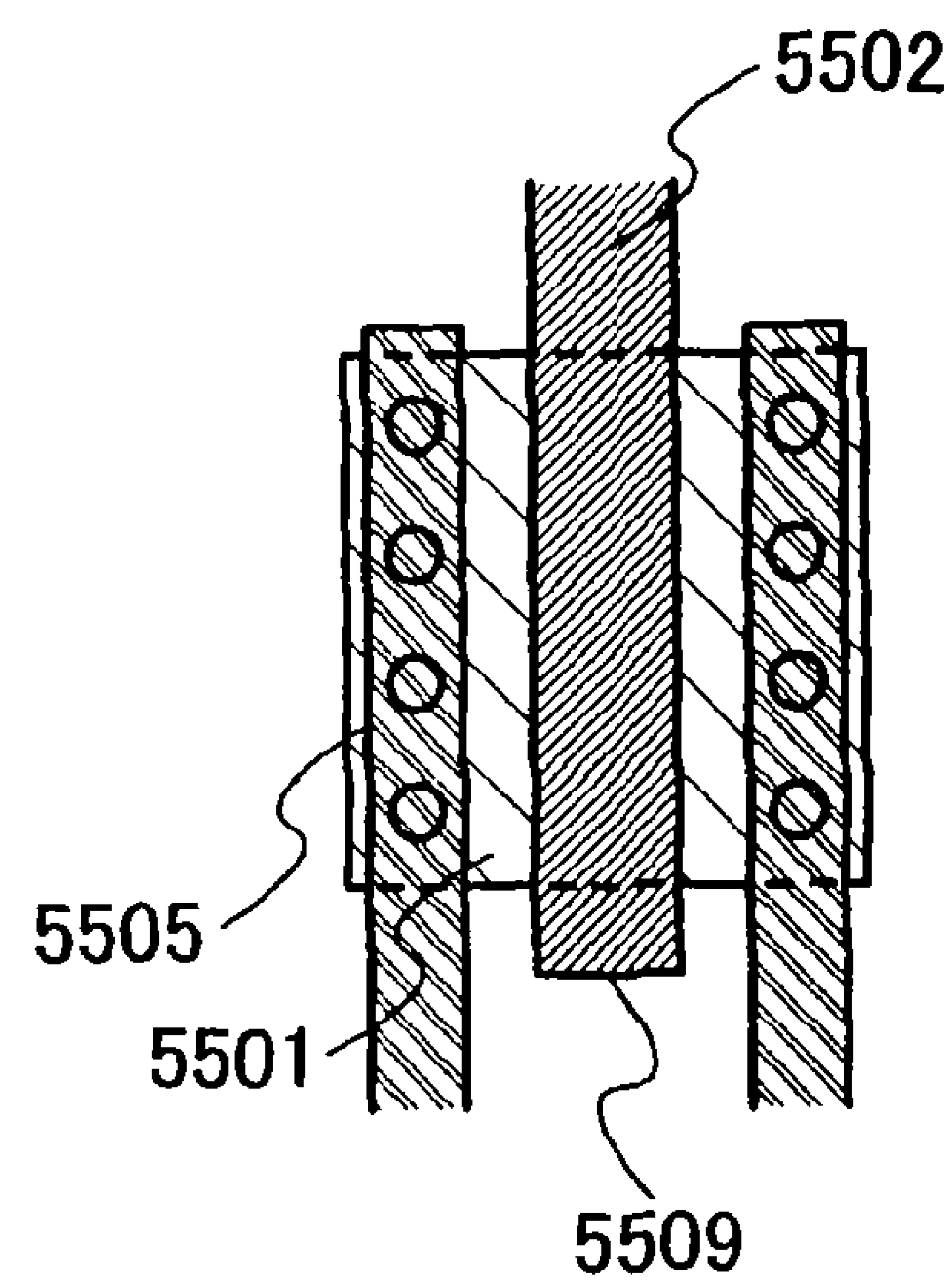


FIG. 41A

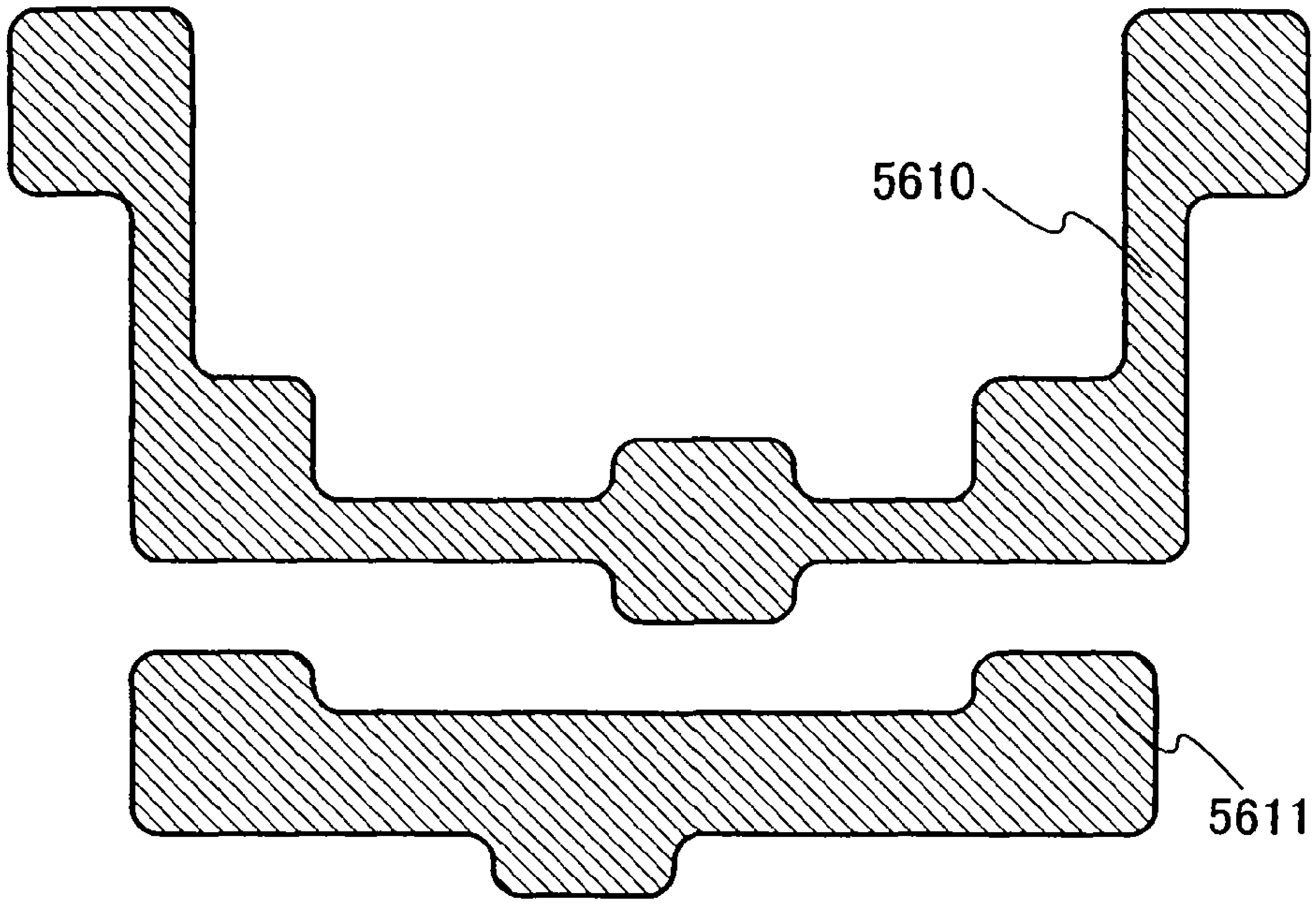


FIG. 41B

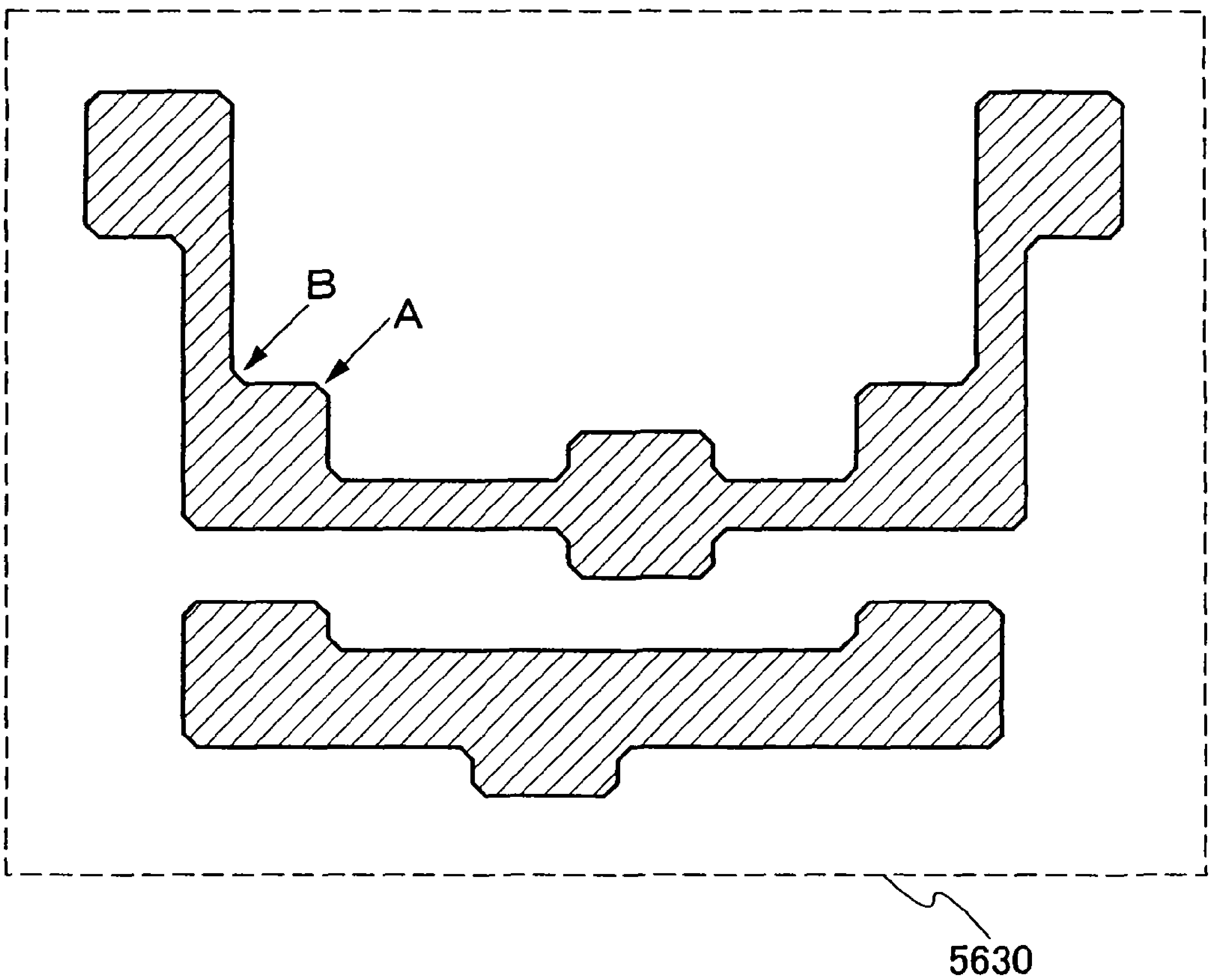


FIG. 42A

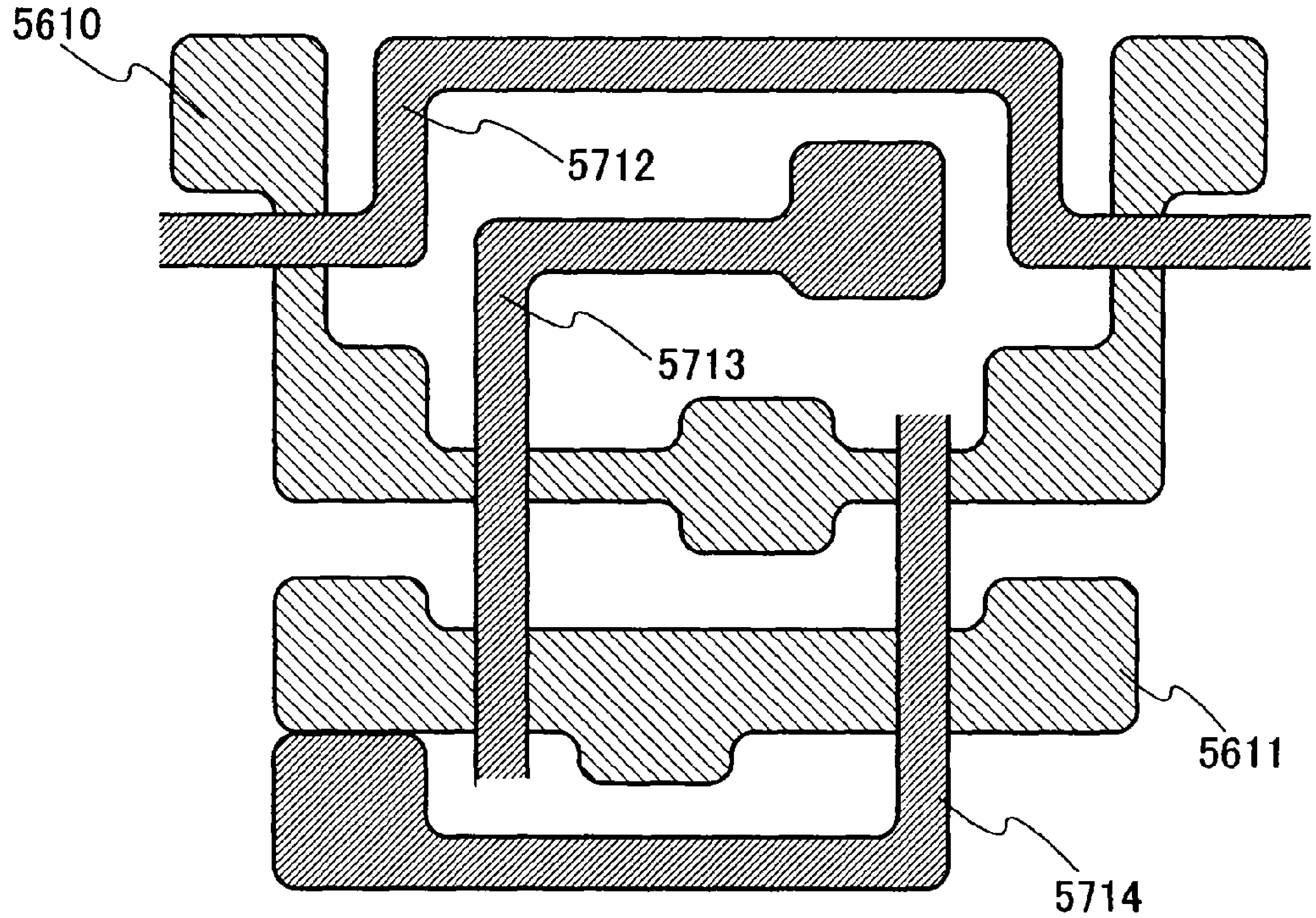


FIG. 42B

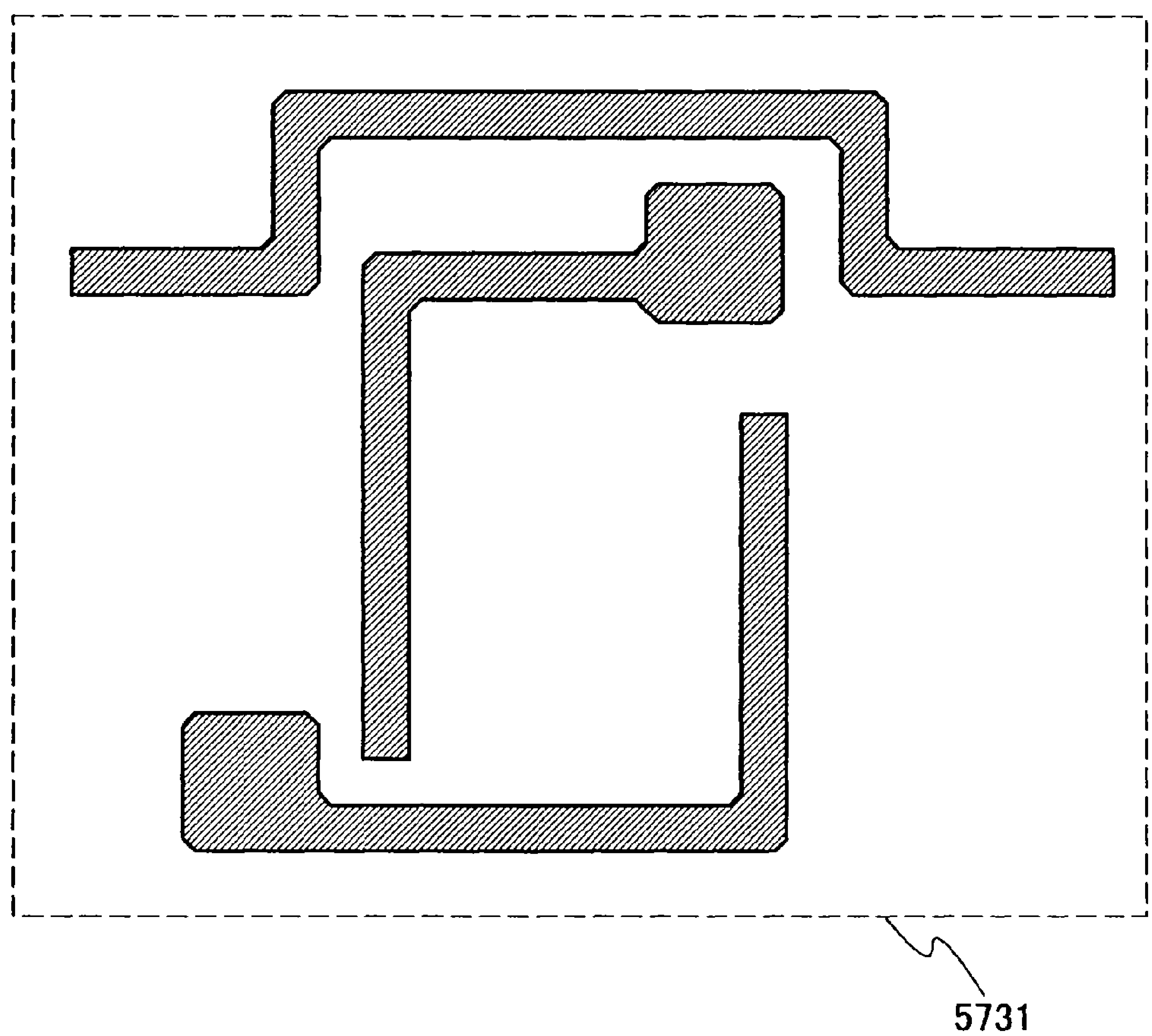


FIG. 43A

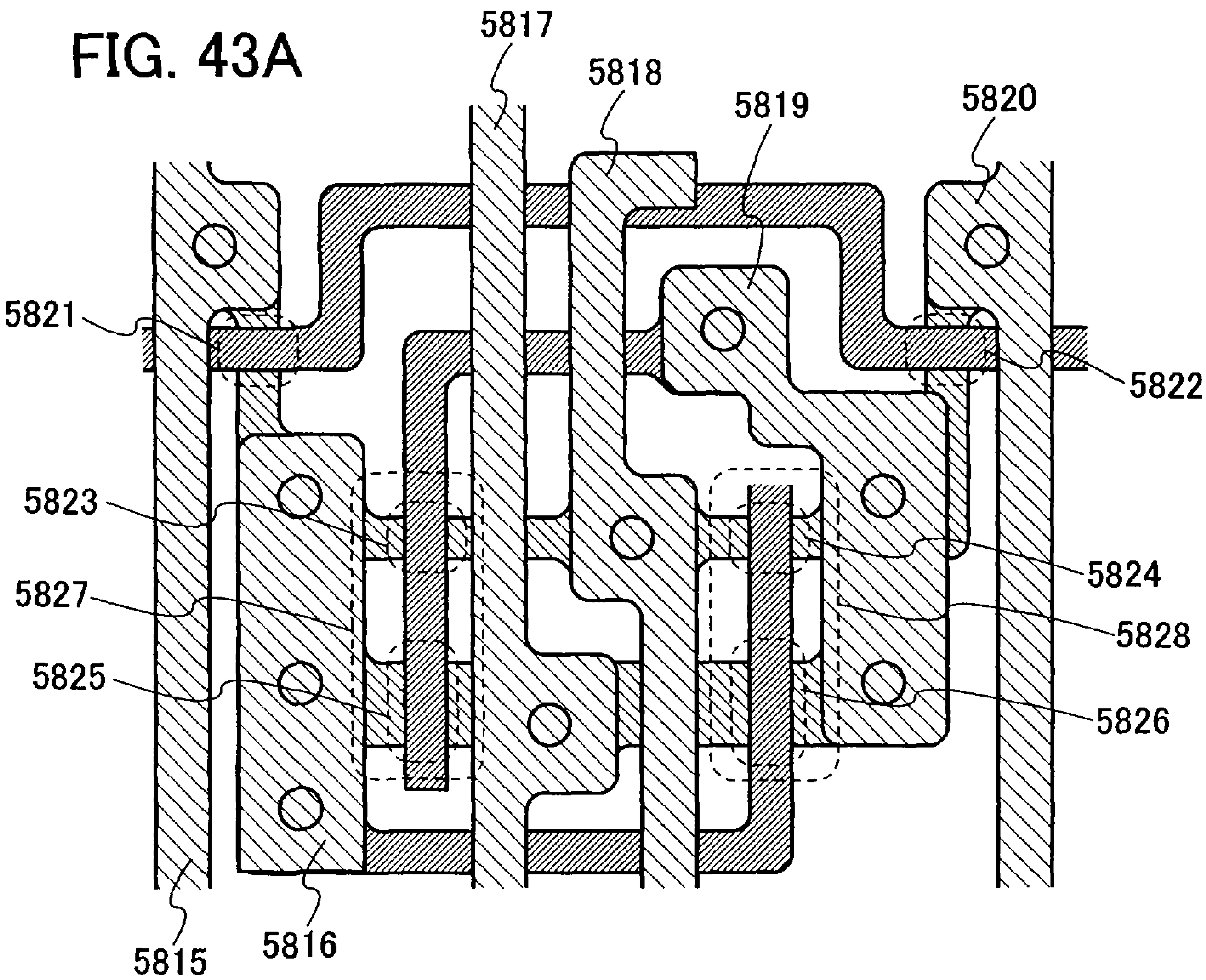


FIG. 43B

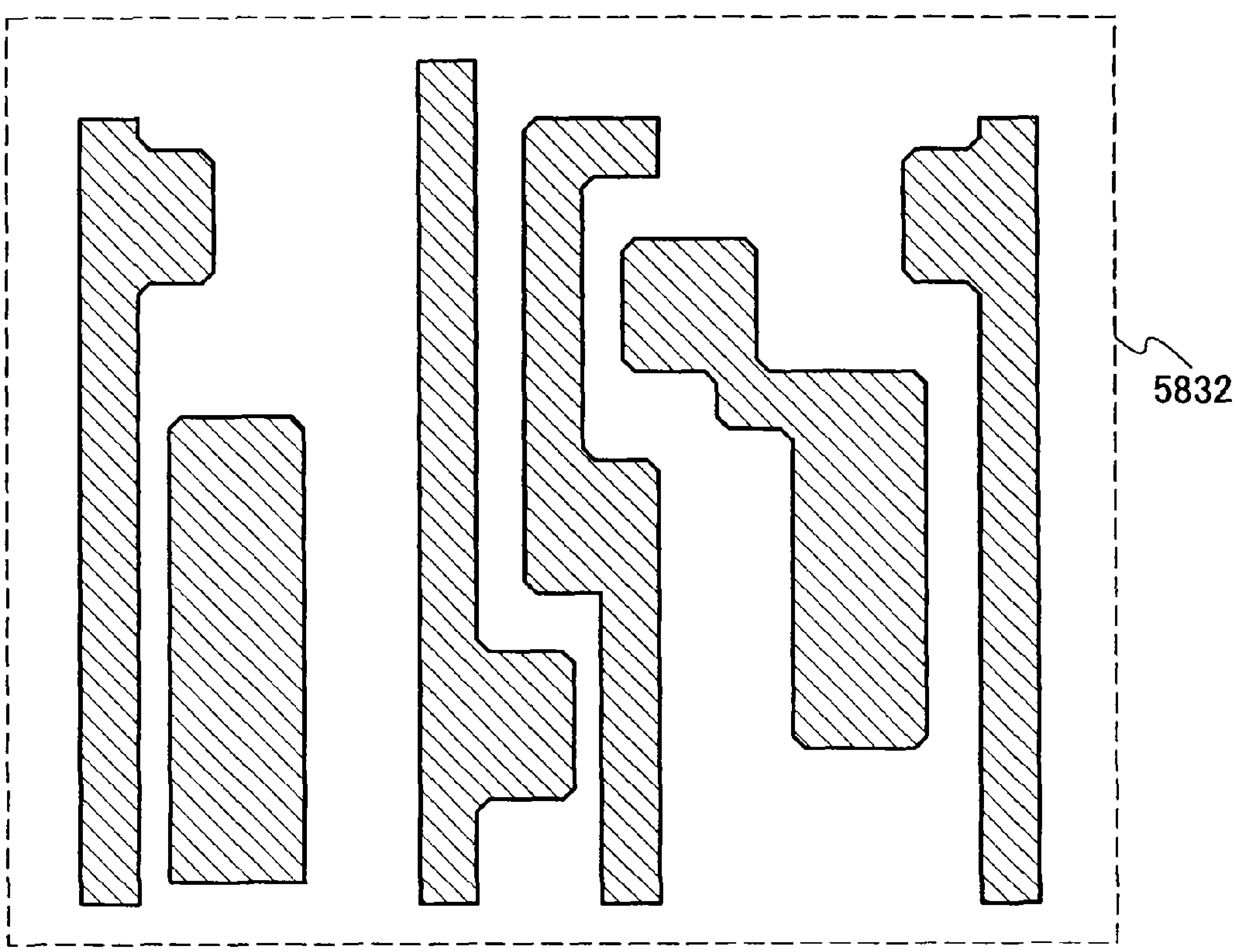


FIG. 44

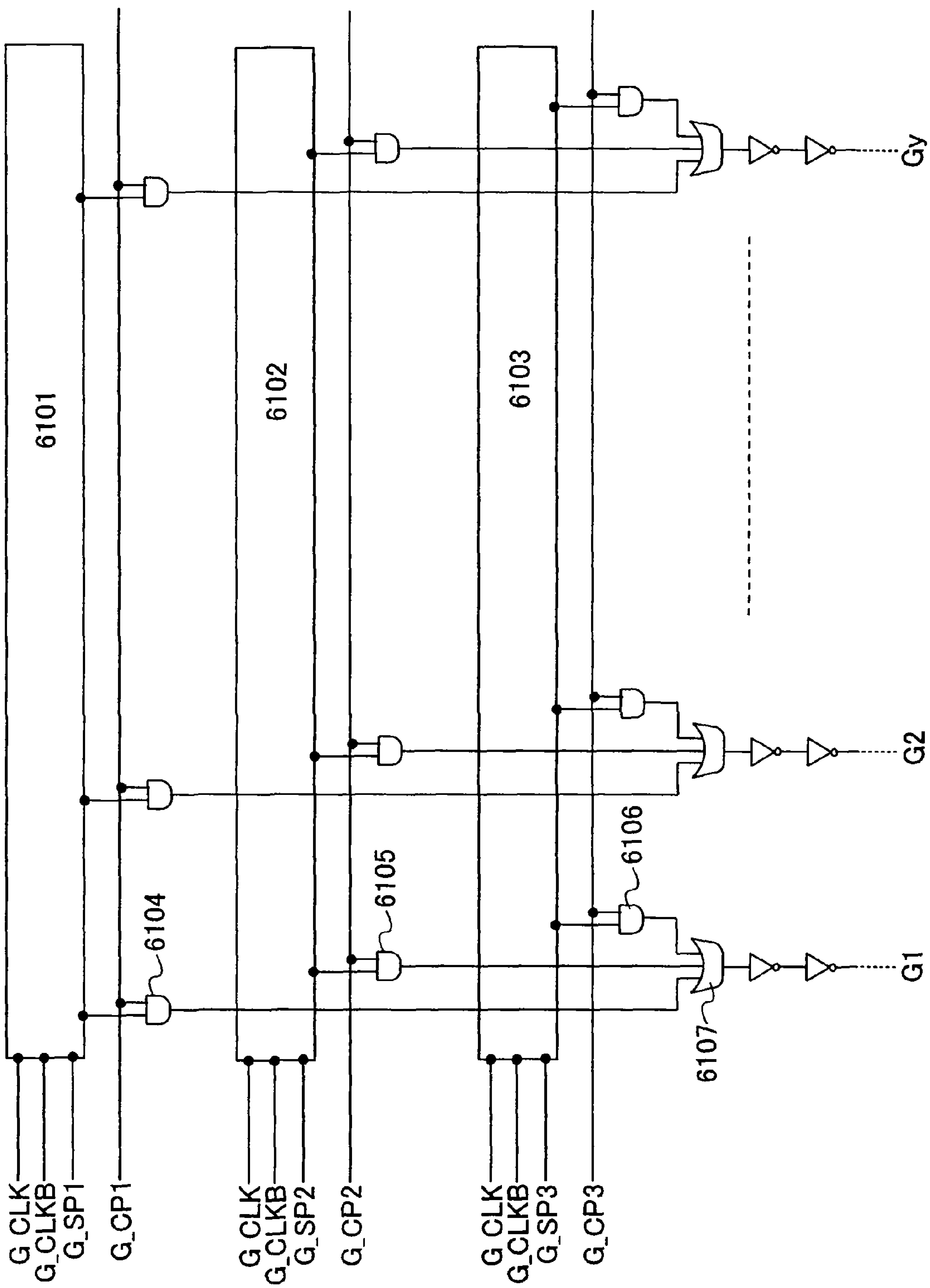

G_CLK
G_CLKB
G_SP1
G_CP1
G_CLK
G_CLKB
G_SP2
G_CP2
G_CLK
G_CLKB
G_SP3
G_CP3
6101
6102
6103
6104
6105
6106
6107
G1
G2
Gy

FIG. 45A

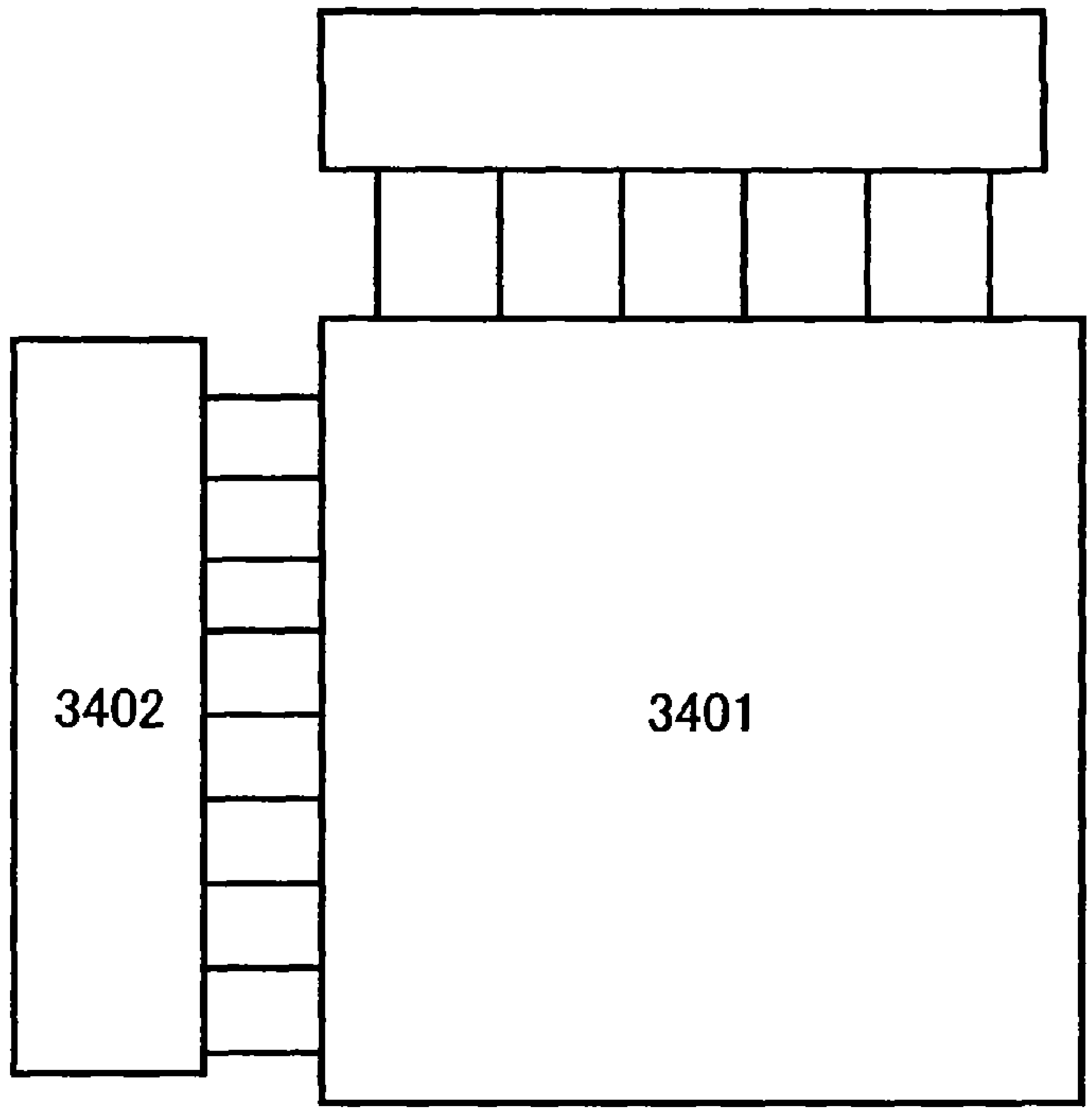


FIG. 45B

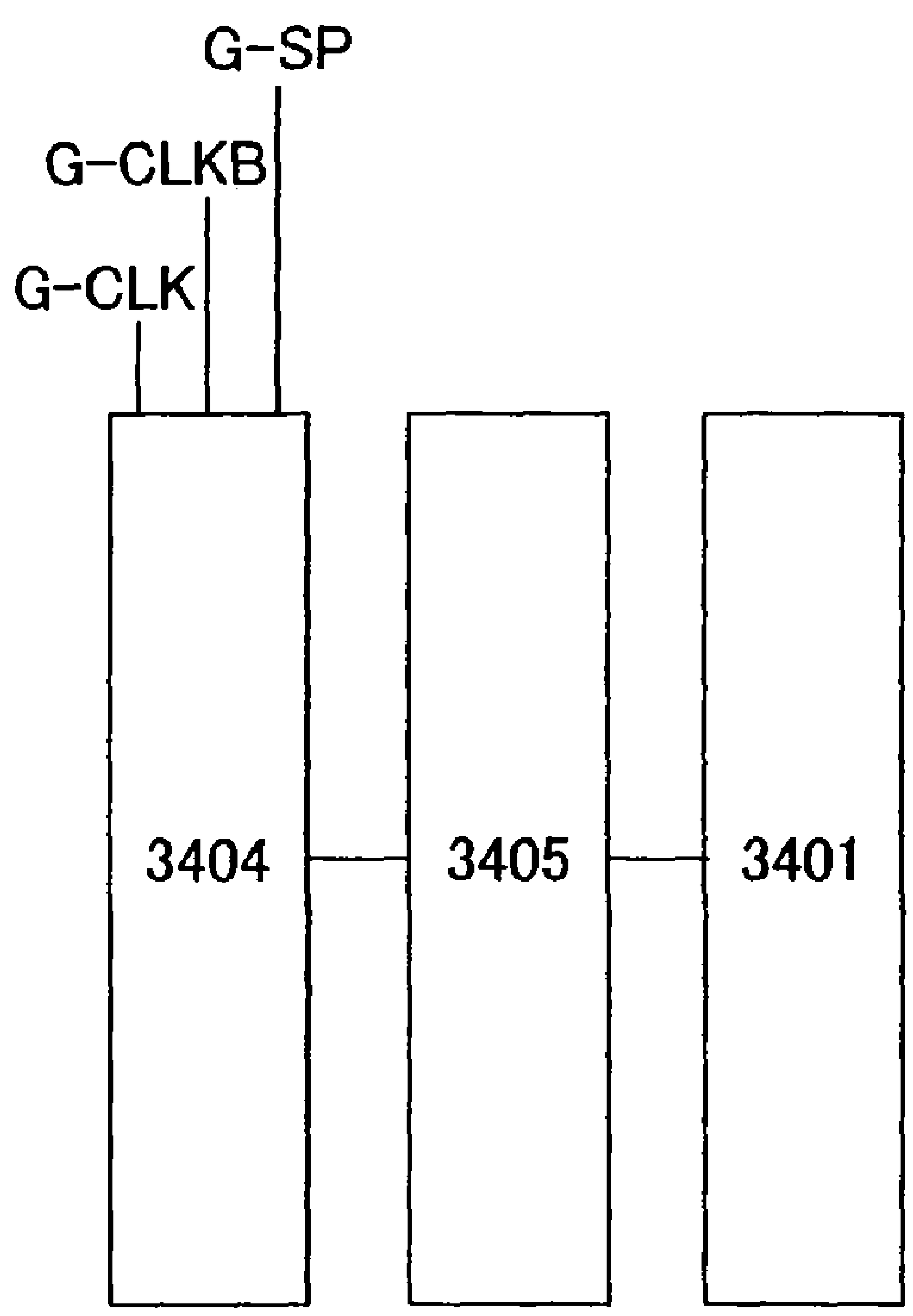


FIG. 45C

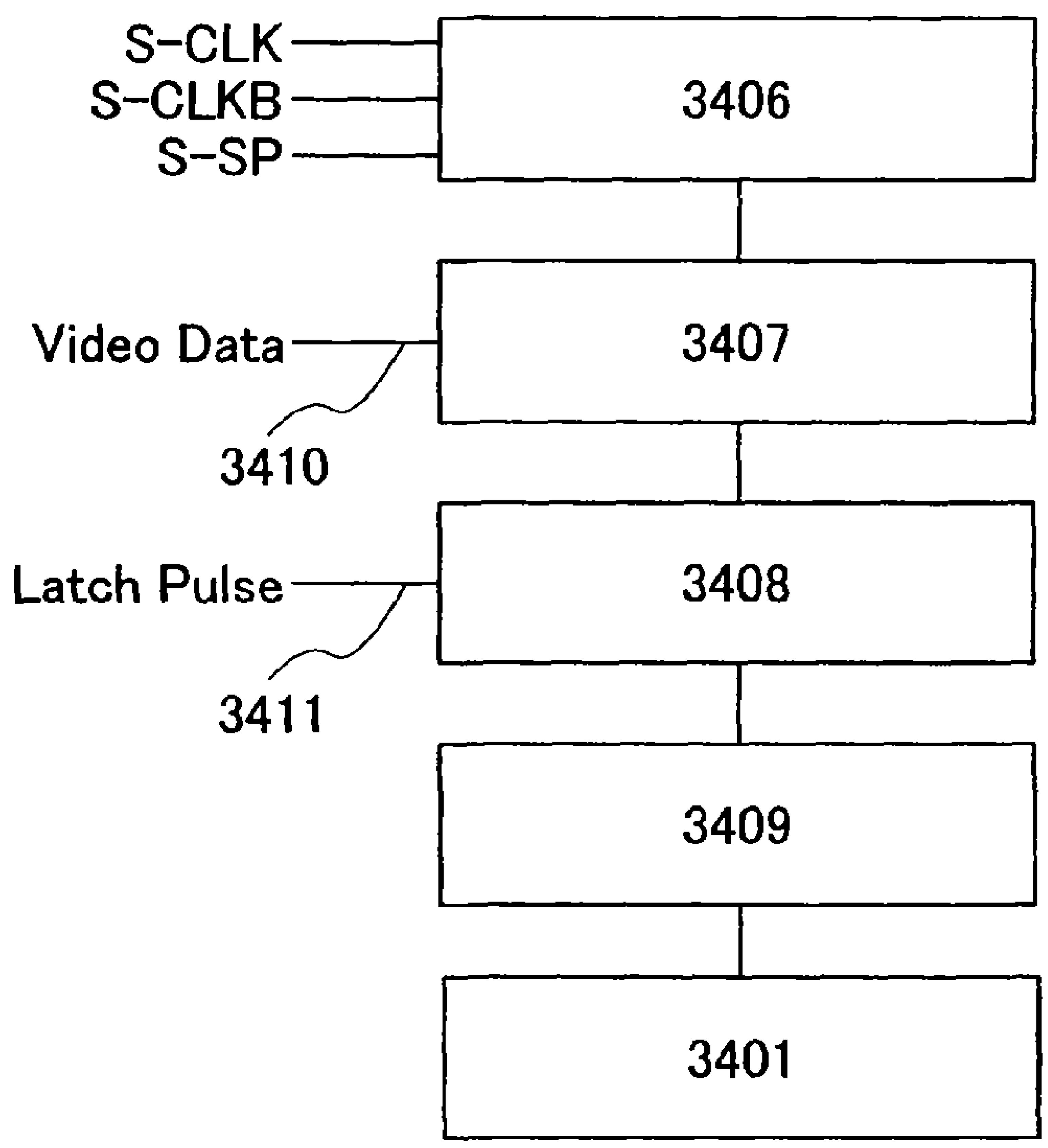


FIG. 46

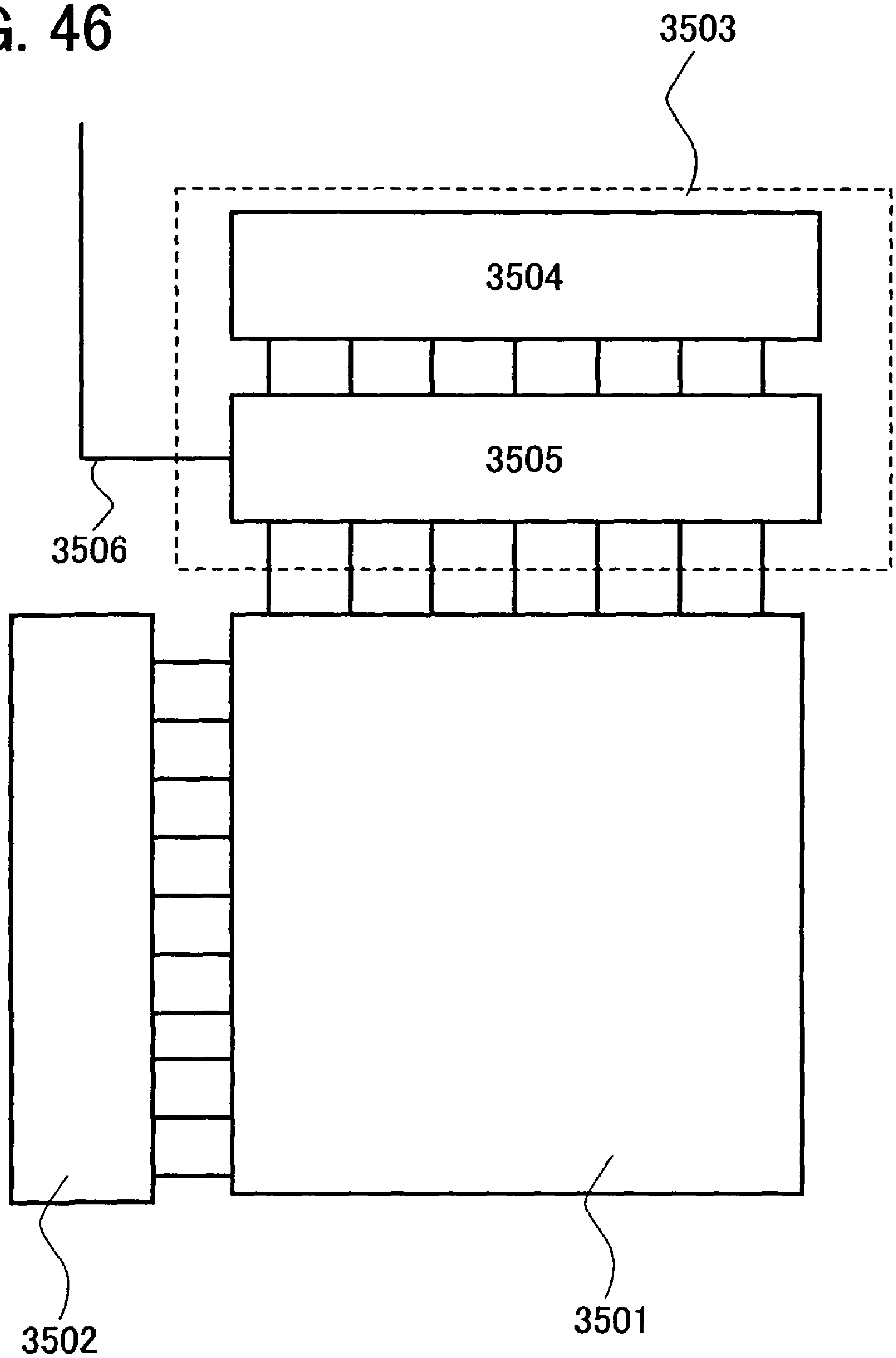


FIG. 47

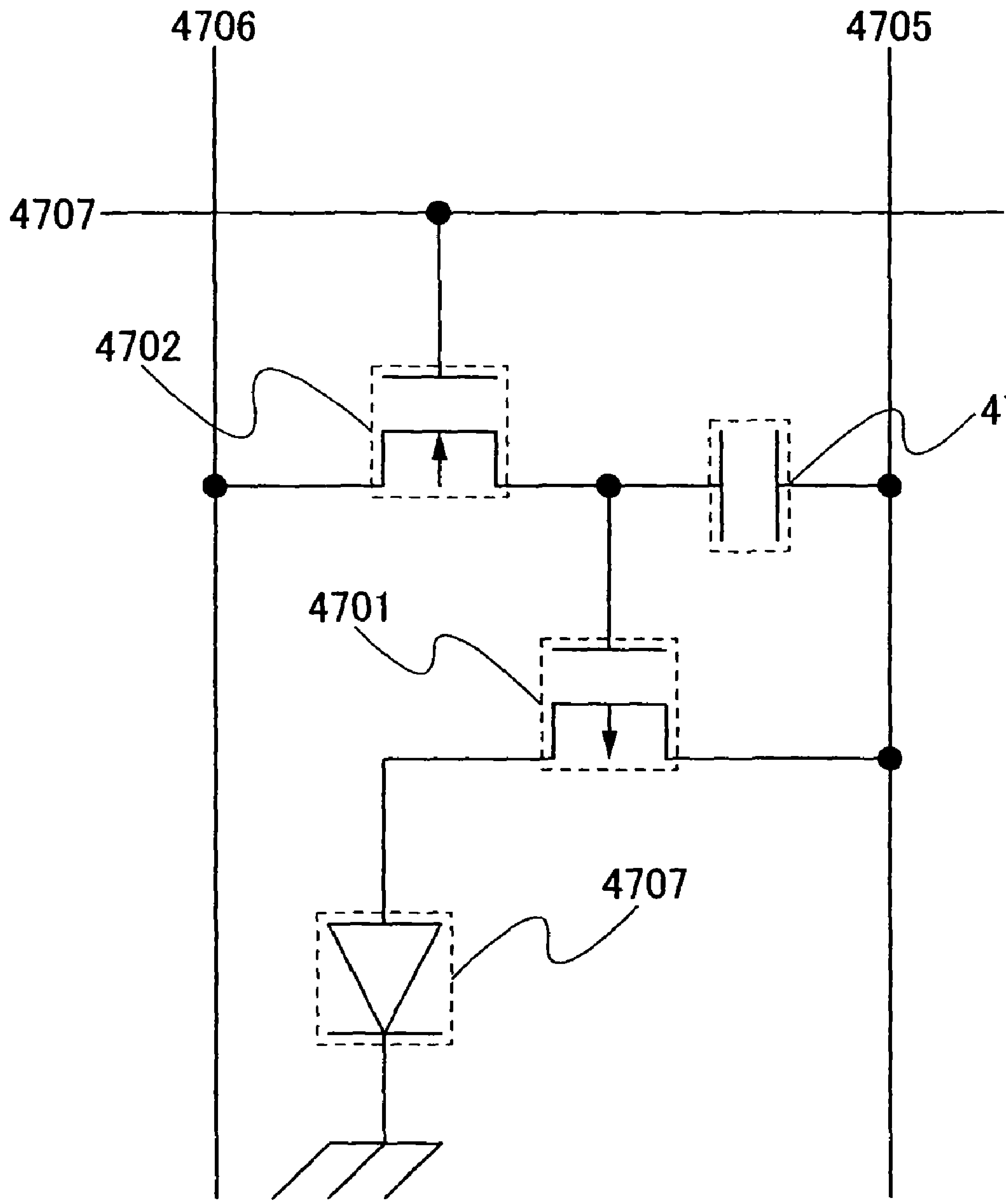


FIG. 48

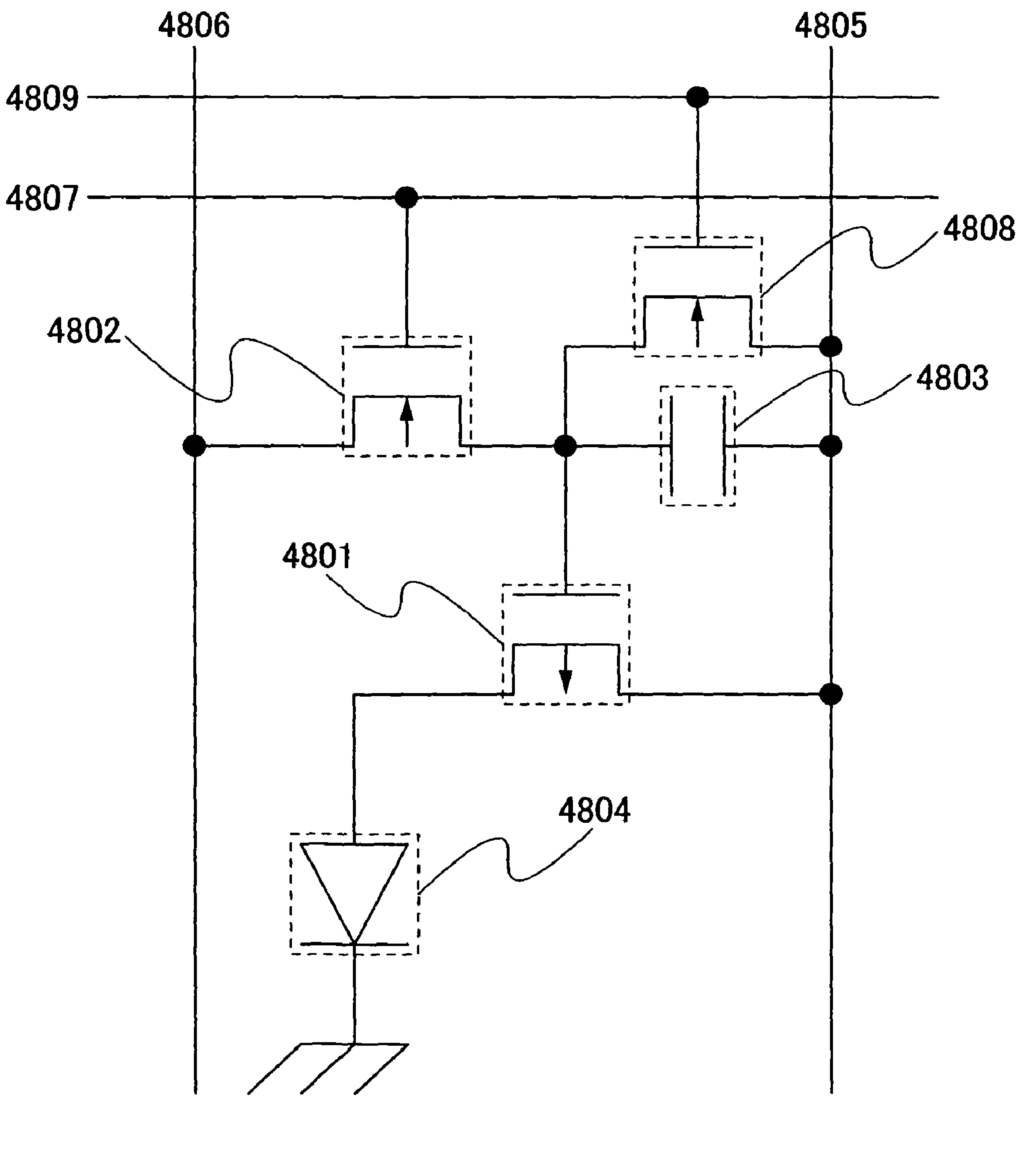


FIG. 49

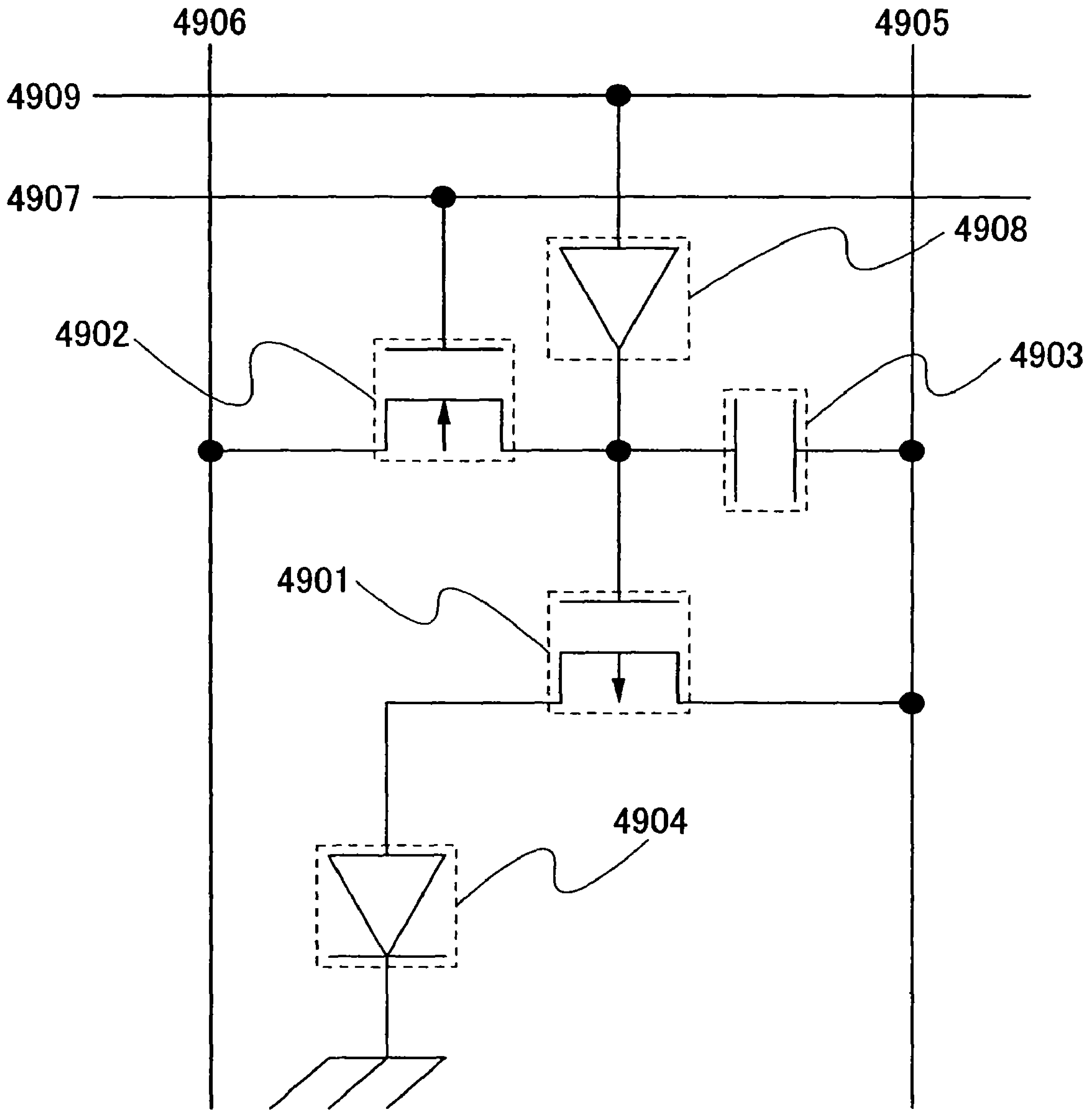


FIG. 50

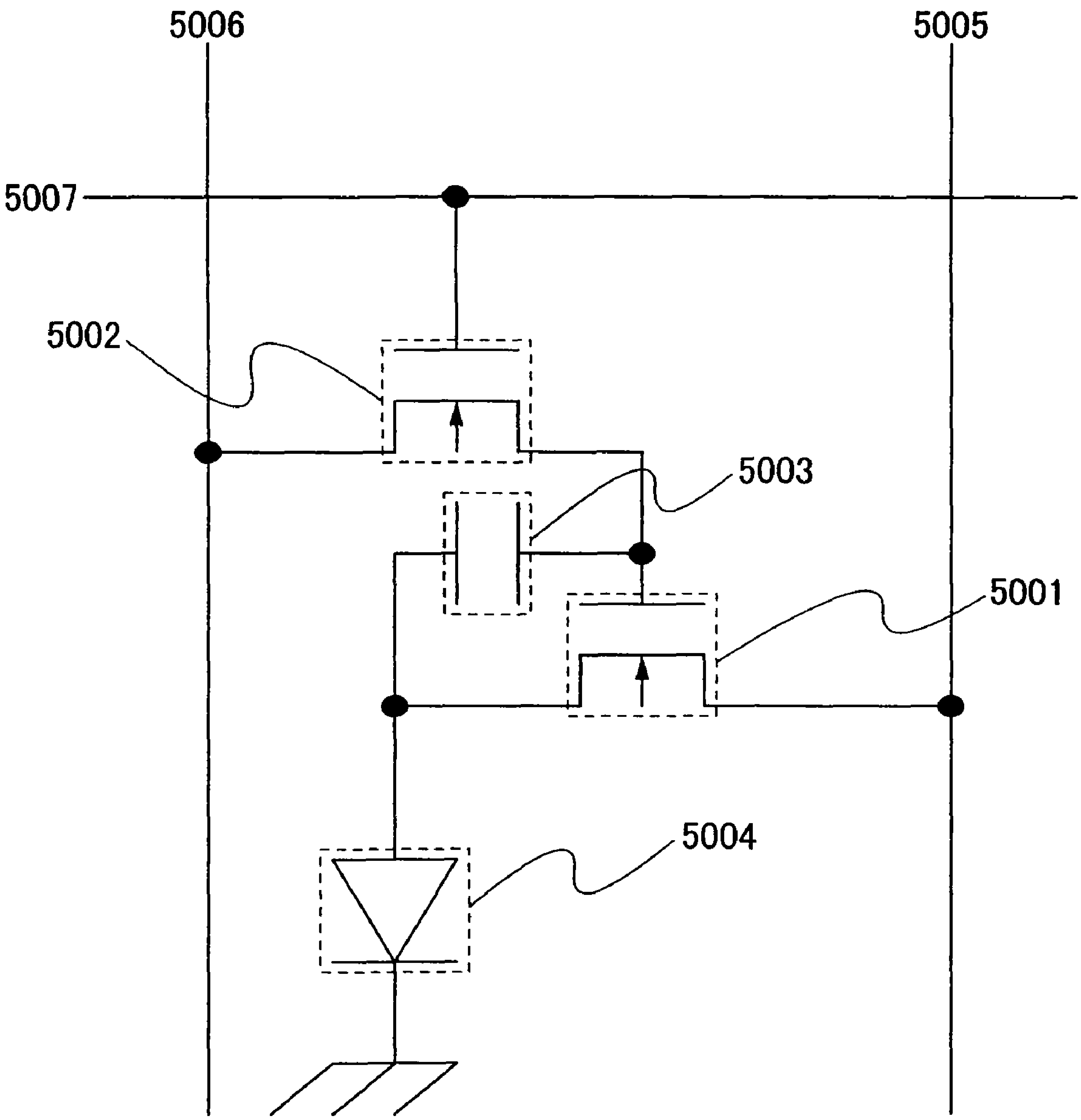


FIG. 51

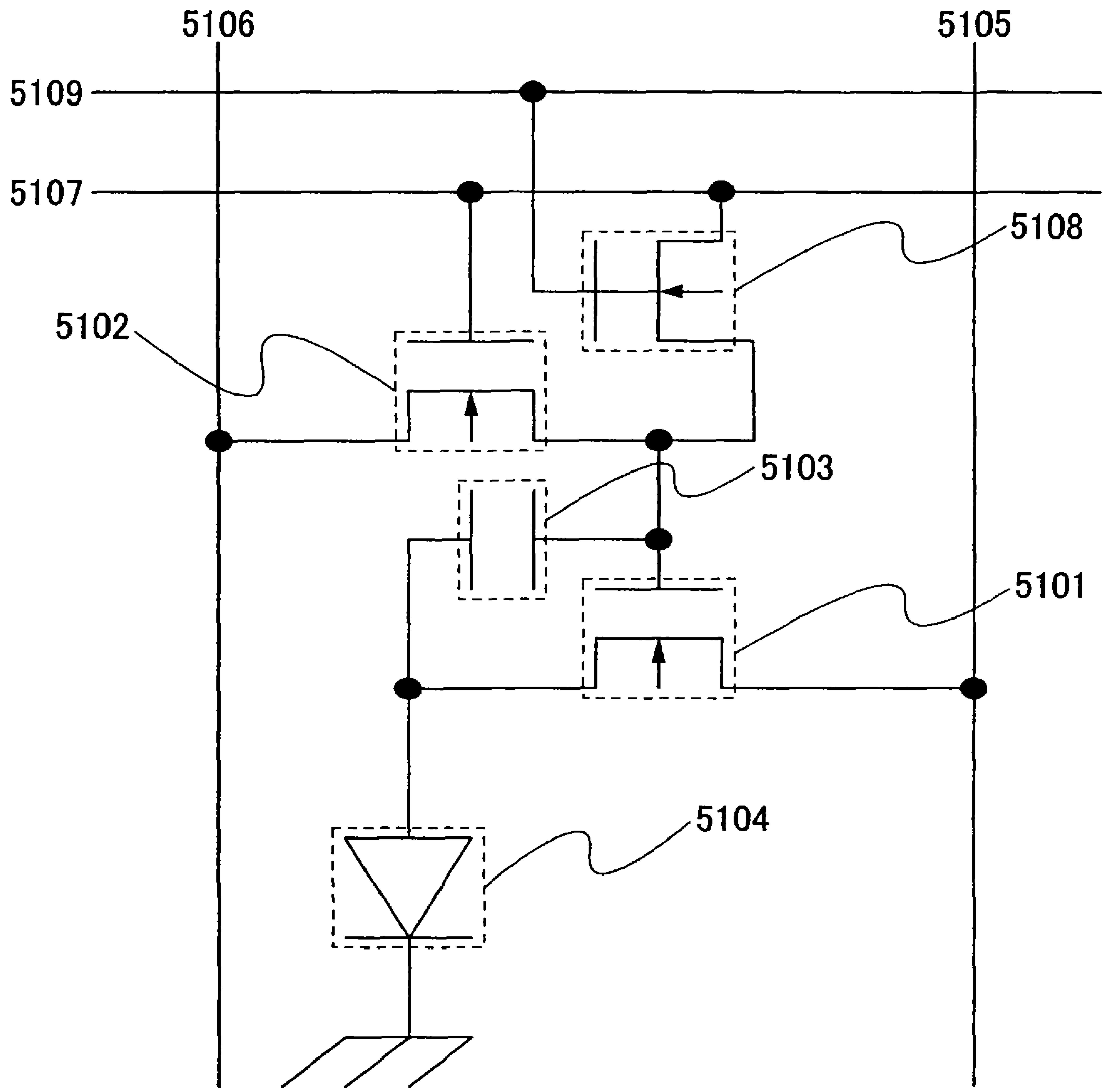


FIG. 52

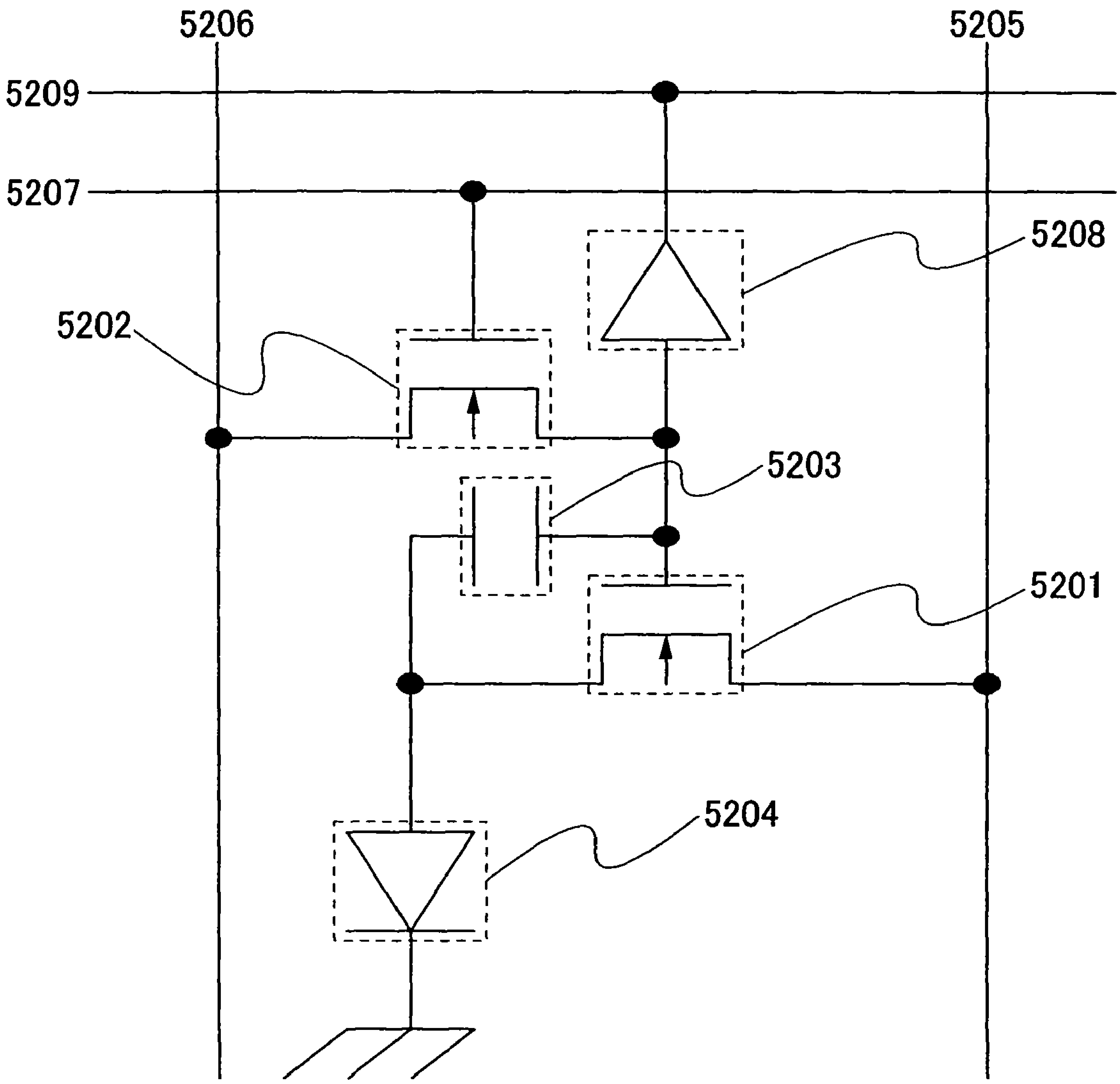


FIG. 53

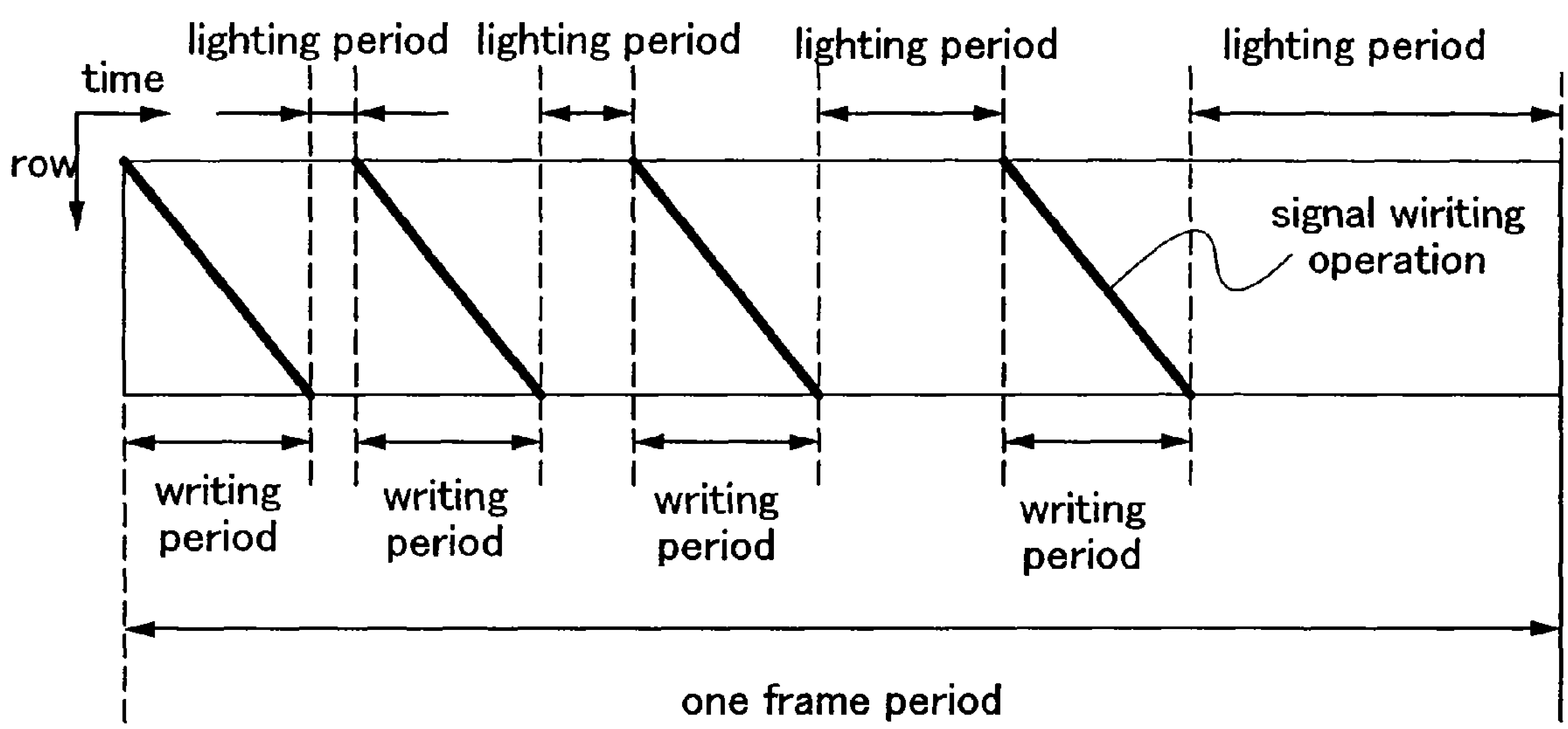

lighting period
lighting period
lighting period
lighting period
time
row
signal wiriting operation
writing period
writing period
writing period
writing period
one frame period

FIG. 54

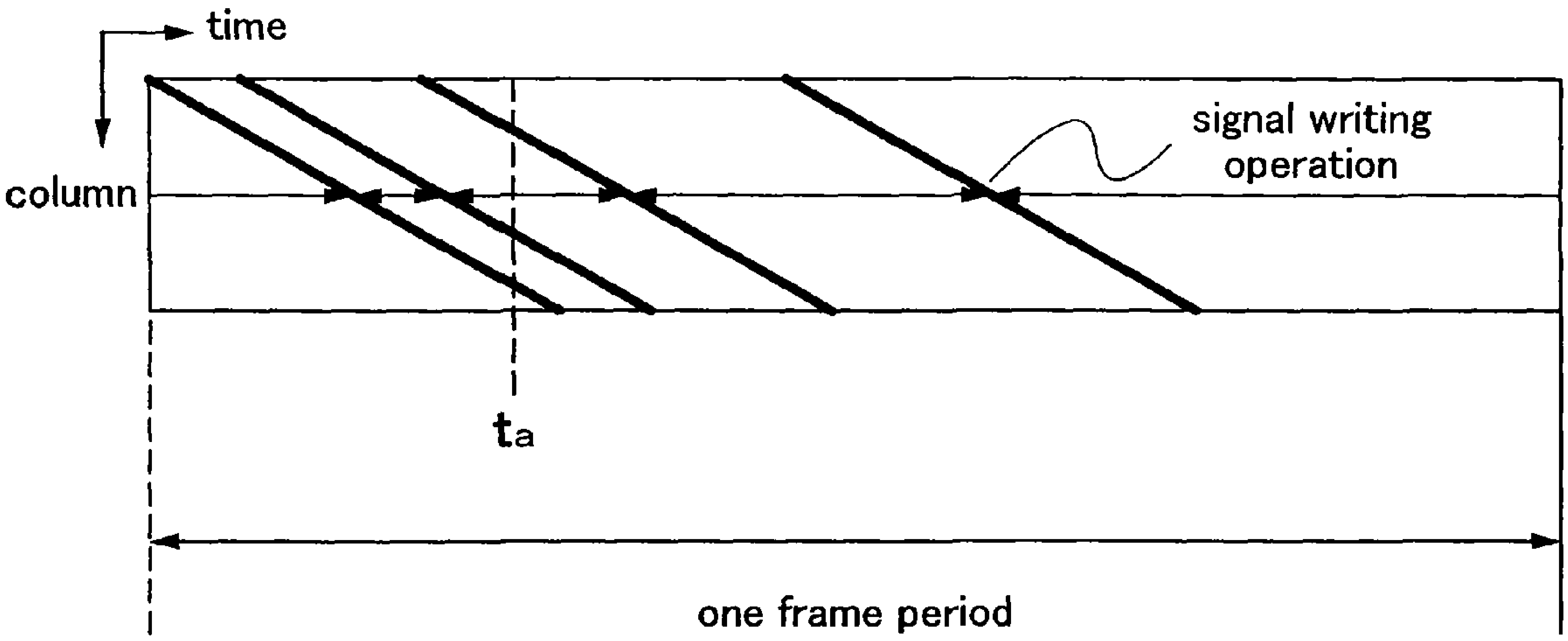


FIG. 55

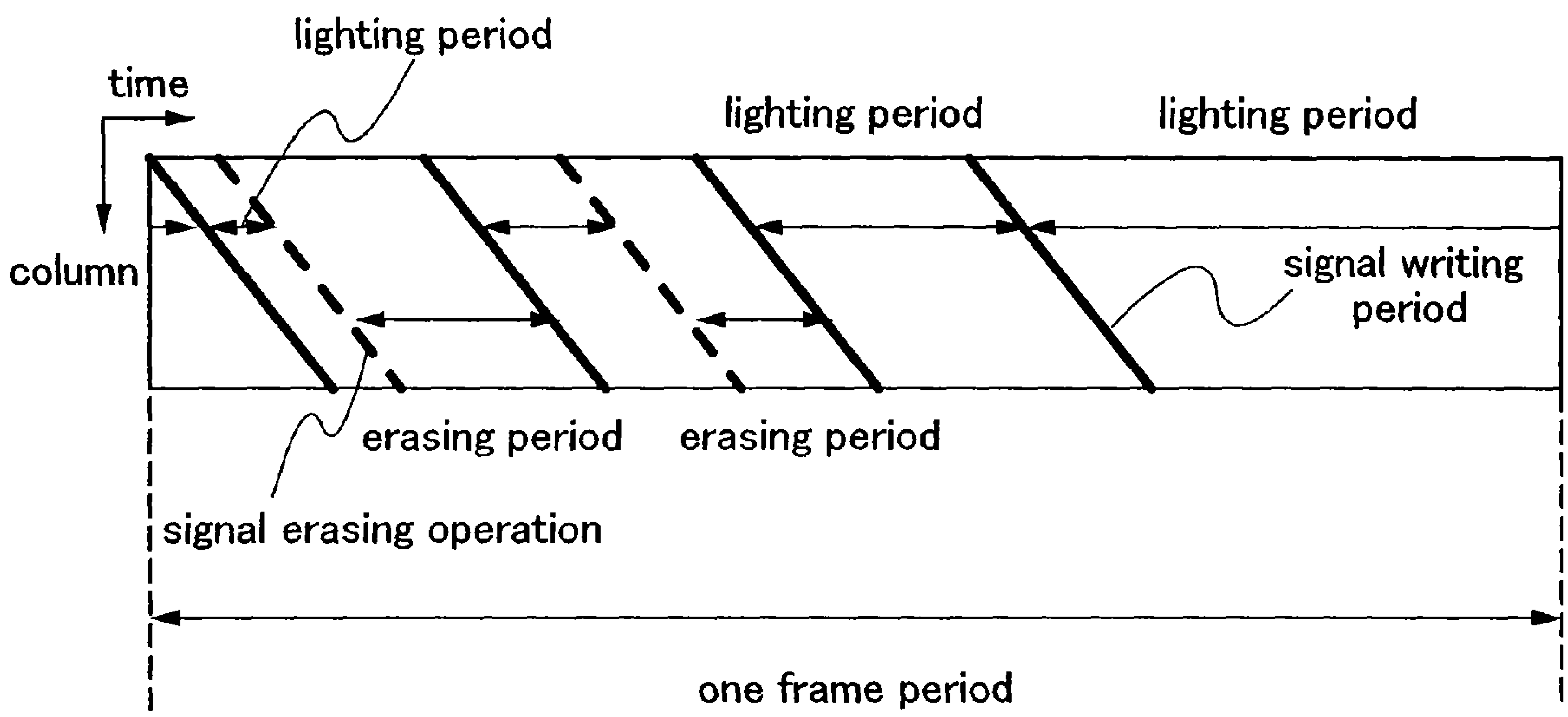
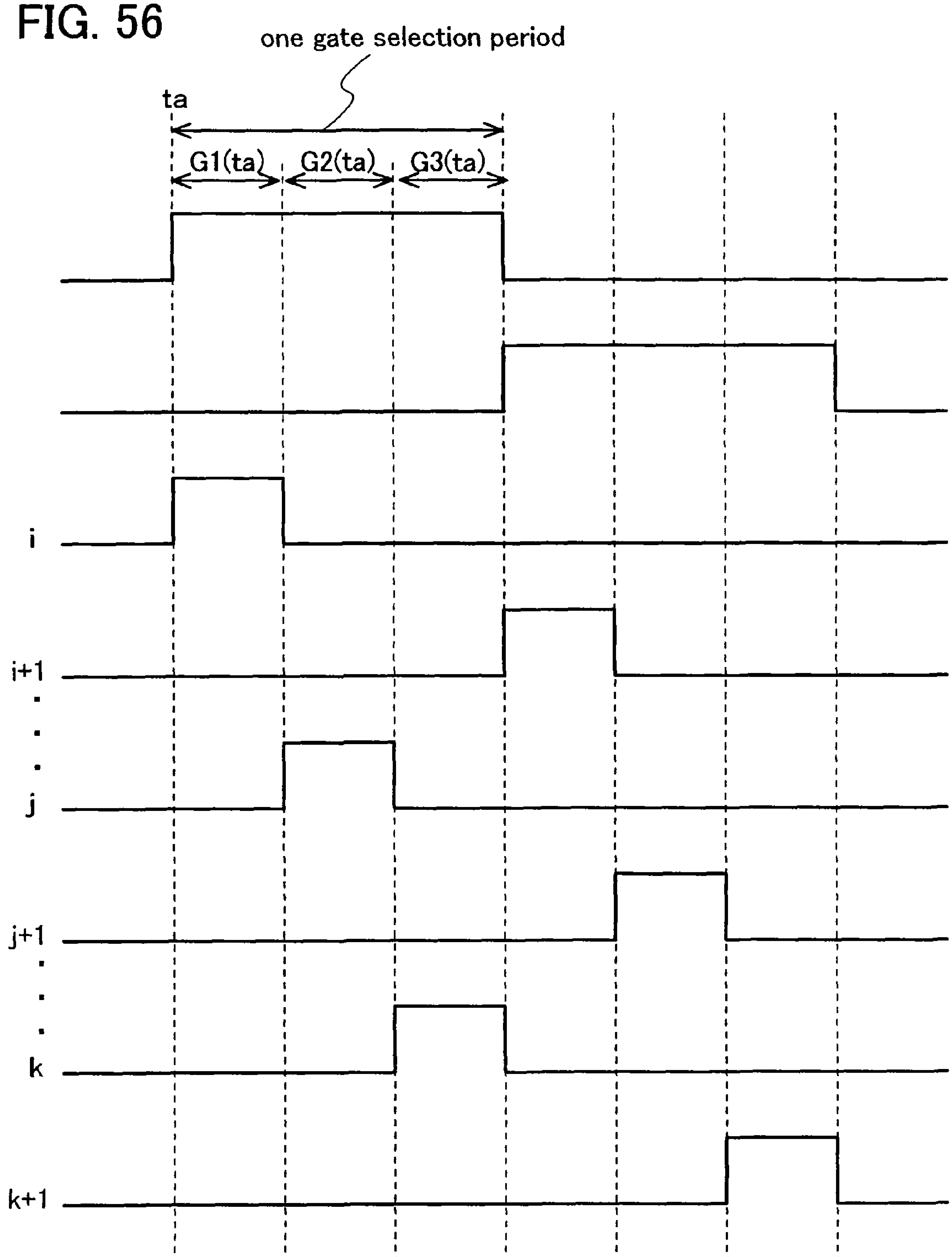

lighting period
time
lighting period
lighting period
column
signal writing period
erasing period
erasing period
signal erasing operation
one frame period

FIG. 56



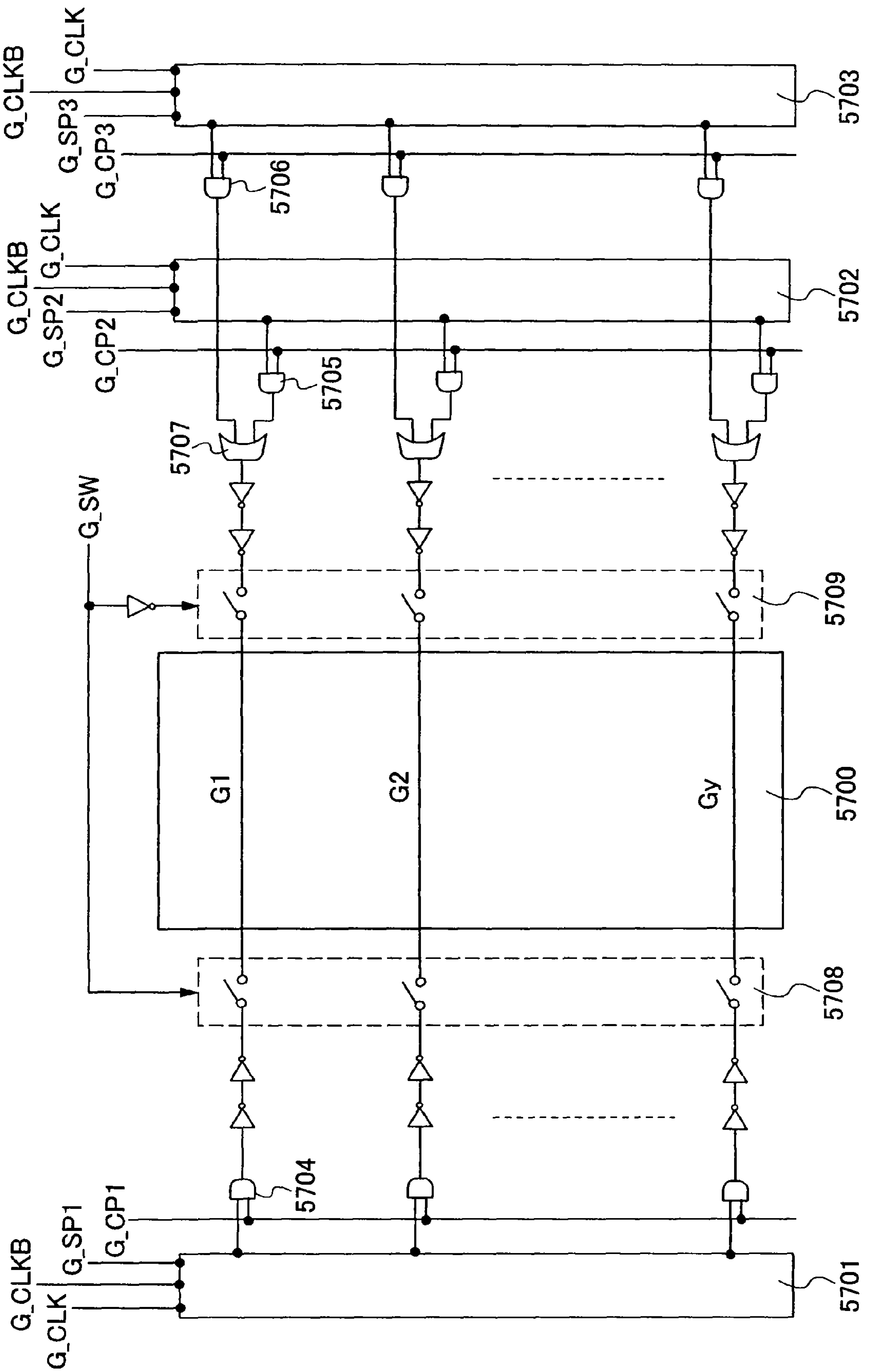
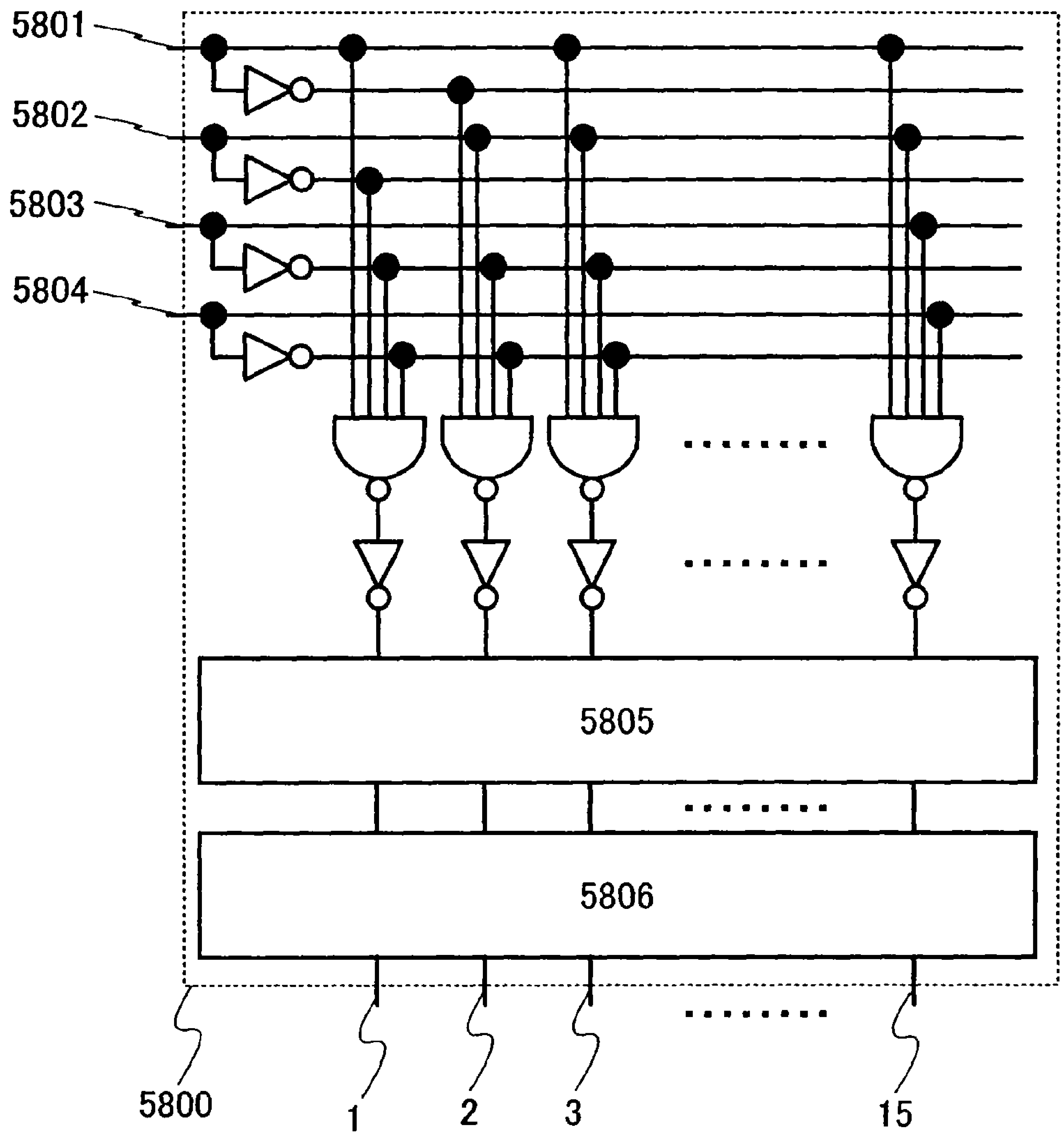

G_CLKB
G_CLK
G_SP3
G_CP3
5703
5706
G_CLKB
G_CLK
G_SP2
G_CP2
5702
5705
5707
G_SW
5709
G1
G2
Gy
5700
5708
5704
G_CLKB
G_CLK
G_SP1
G_CP1
5701

FIG. 57

FIG. 58



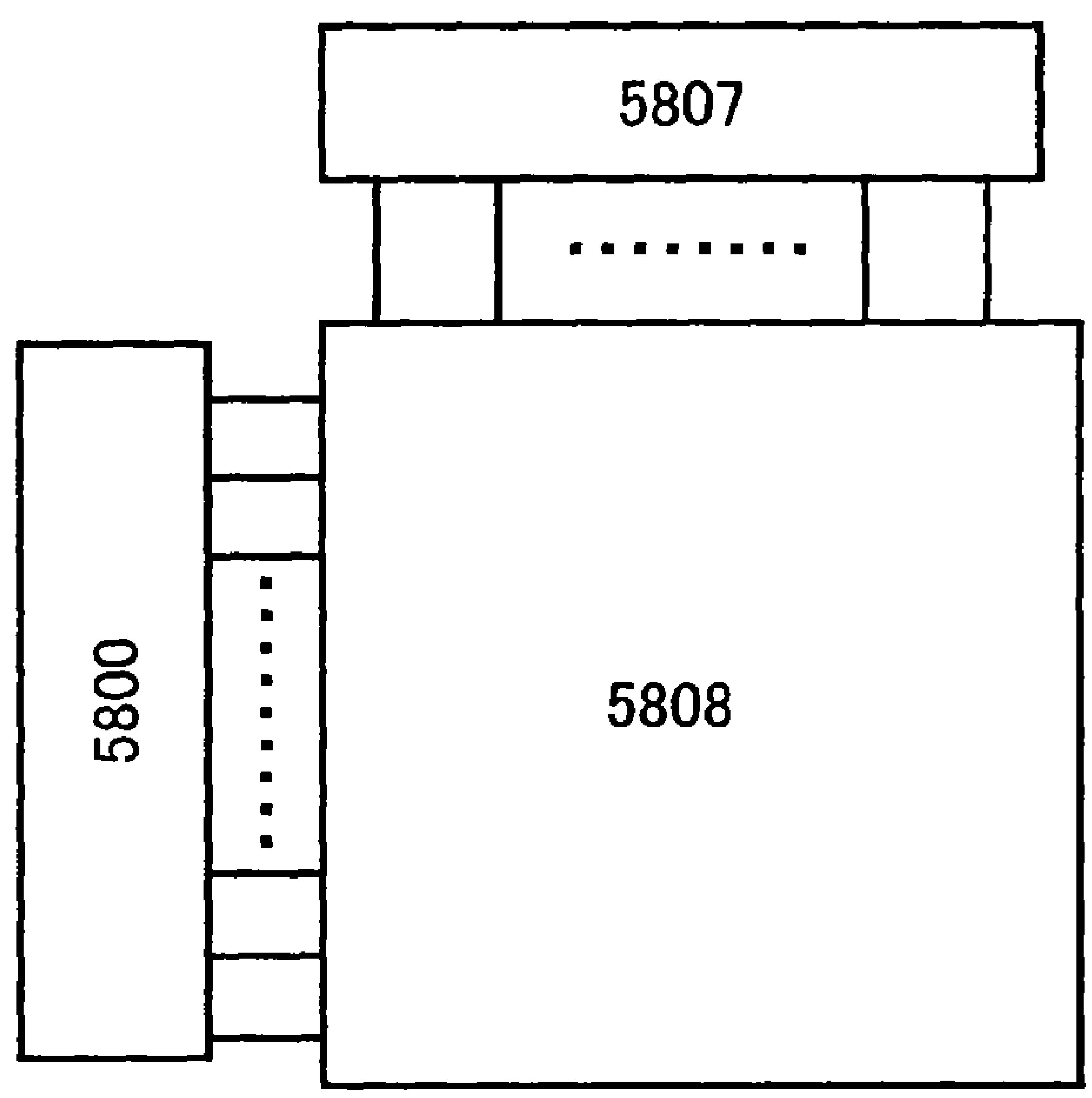


FIG. 59

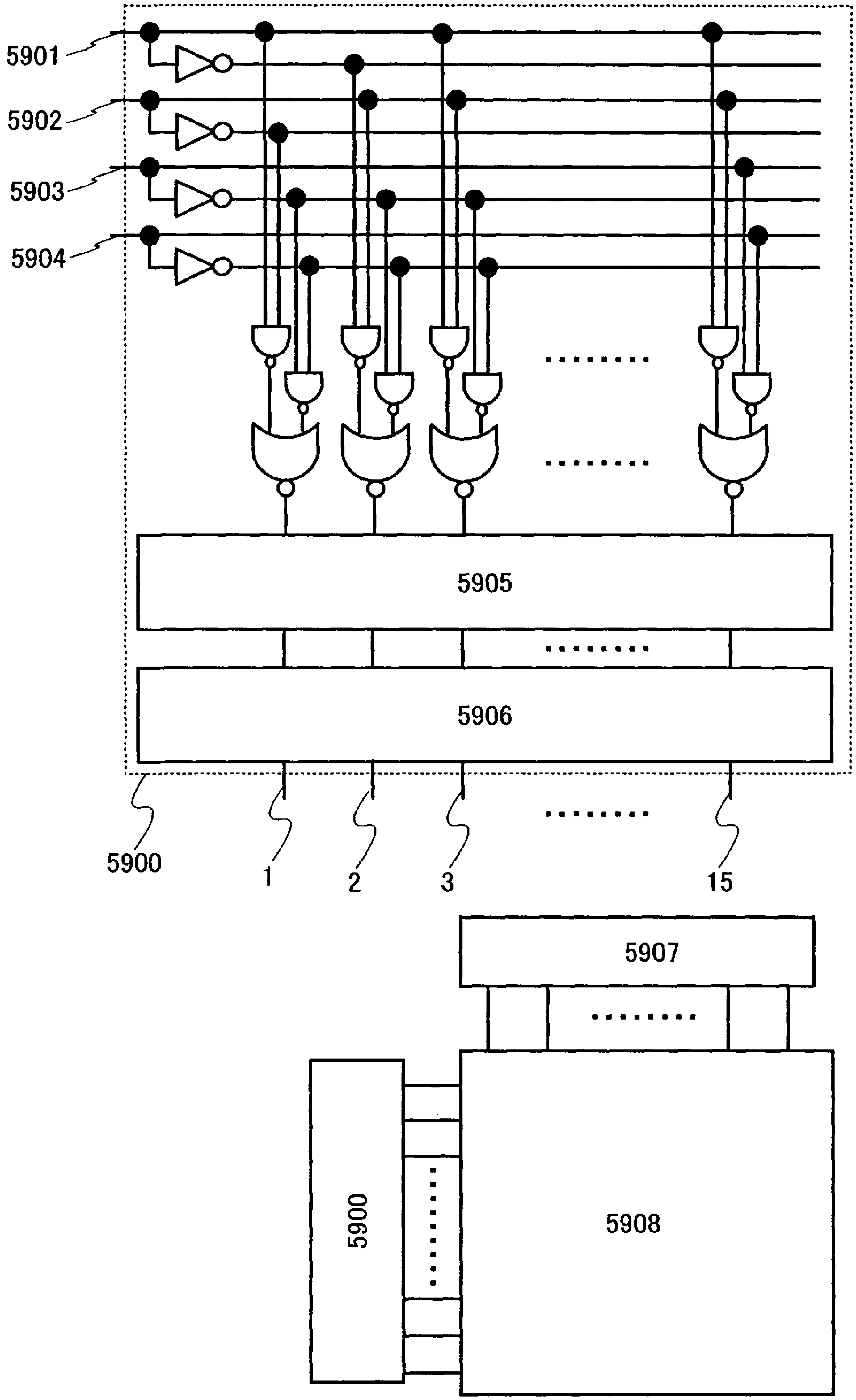


FIG. 60

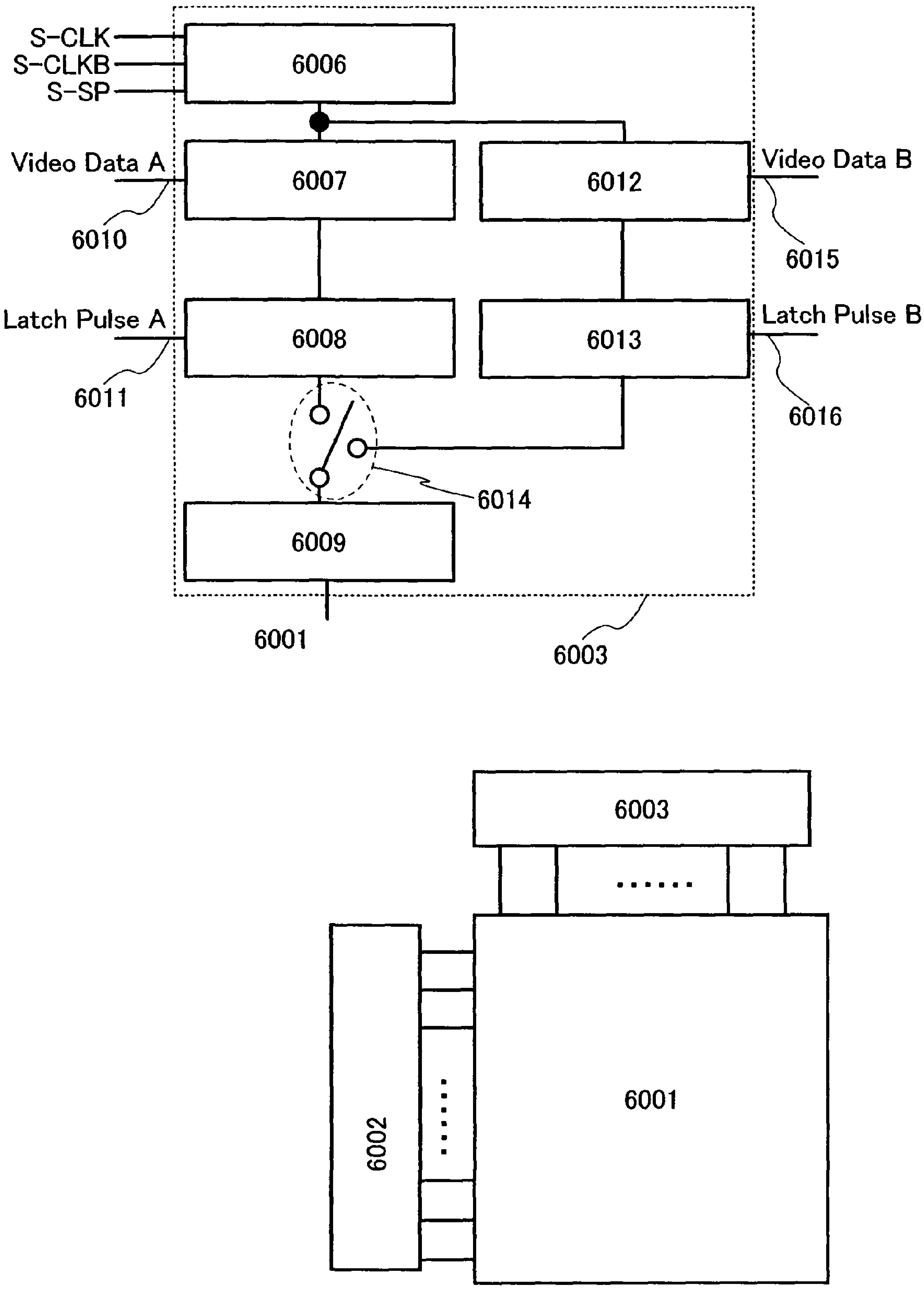

S-CLK
S-CLKB
S-SP
6006
Video Data A
6007
6012
Video Data B
6010
6015
Latch Pulse A
6008
6013
Latch Pulse B
6011
6016
6014
6009
6001
6003
6003
6002
6001

FIG. 61

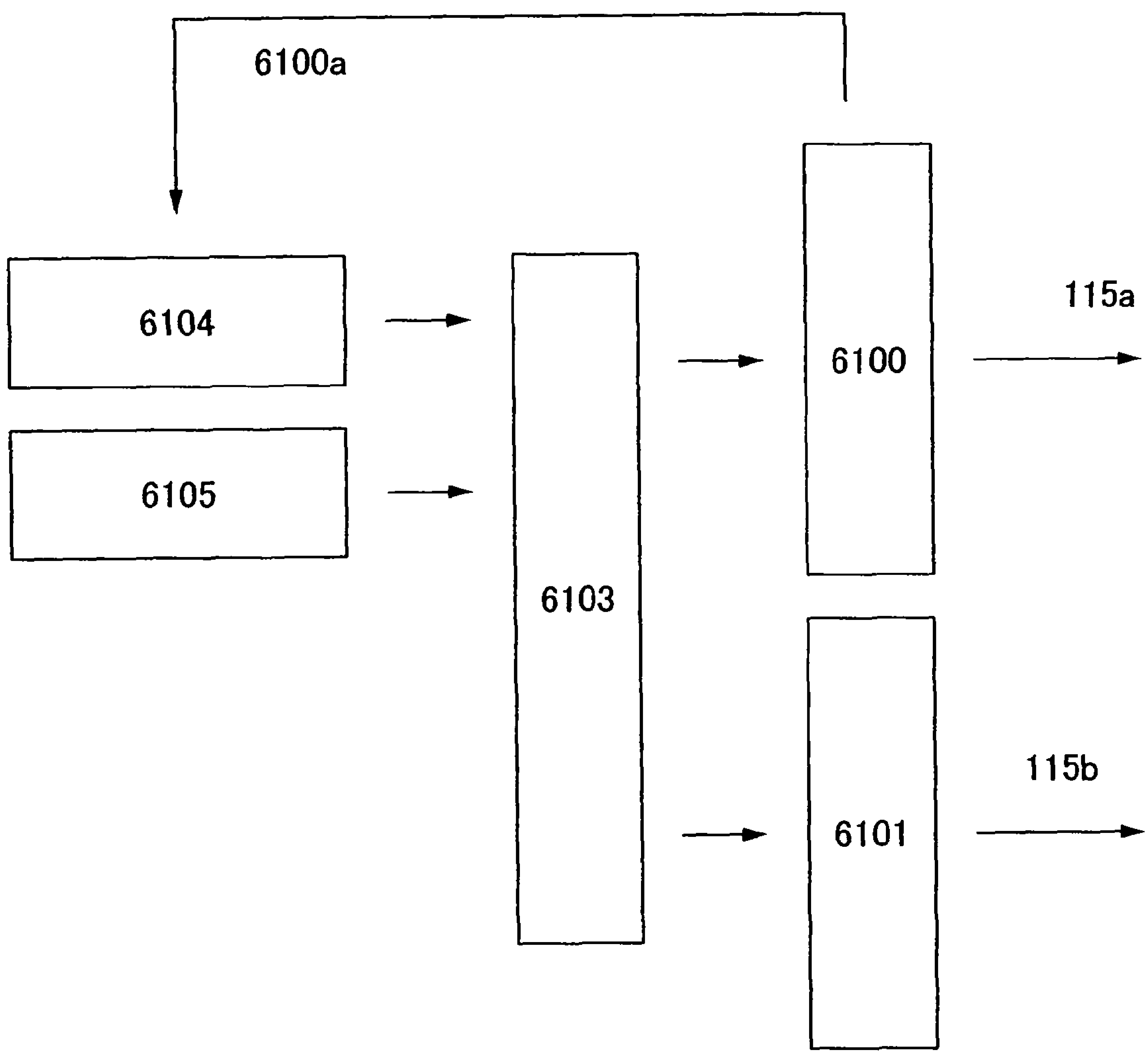


FIG. 62

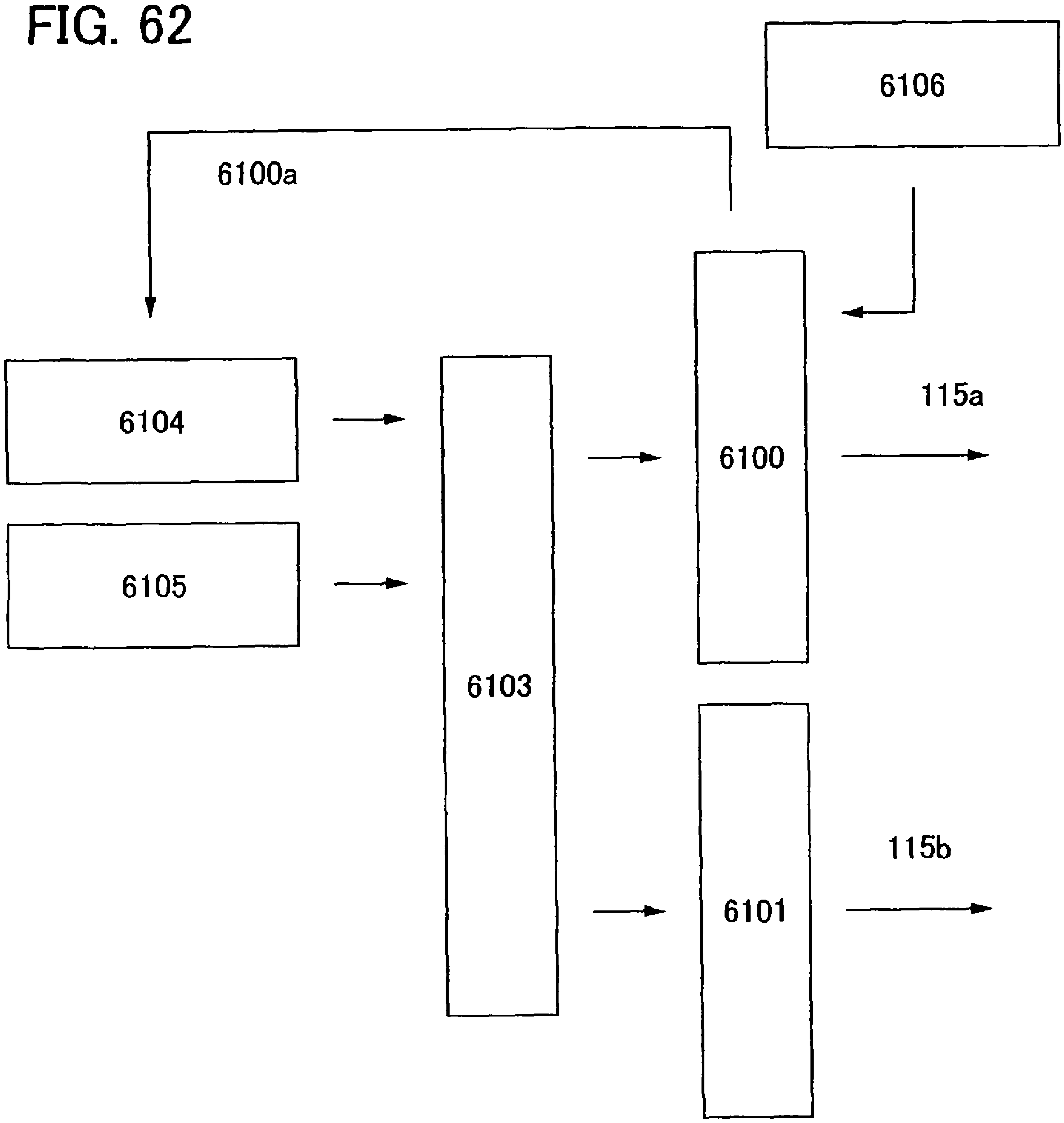


FIG. 63

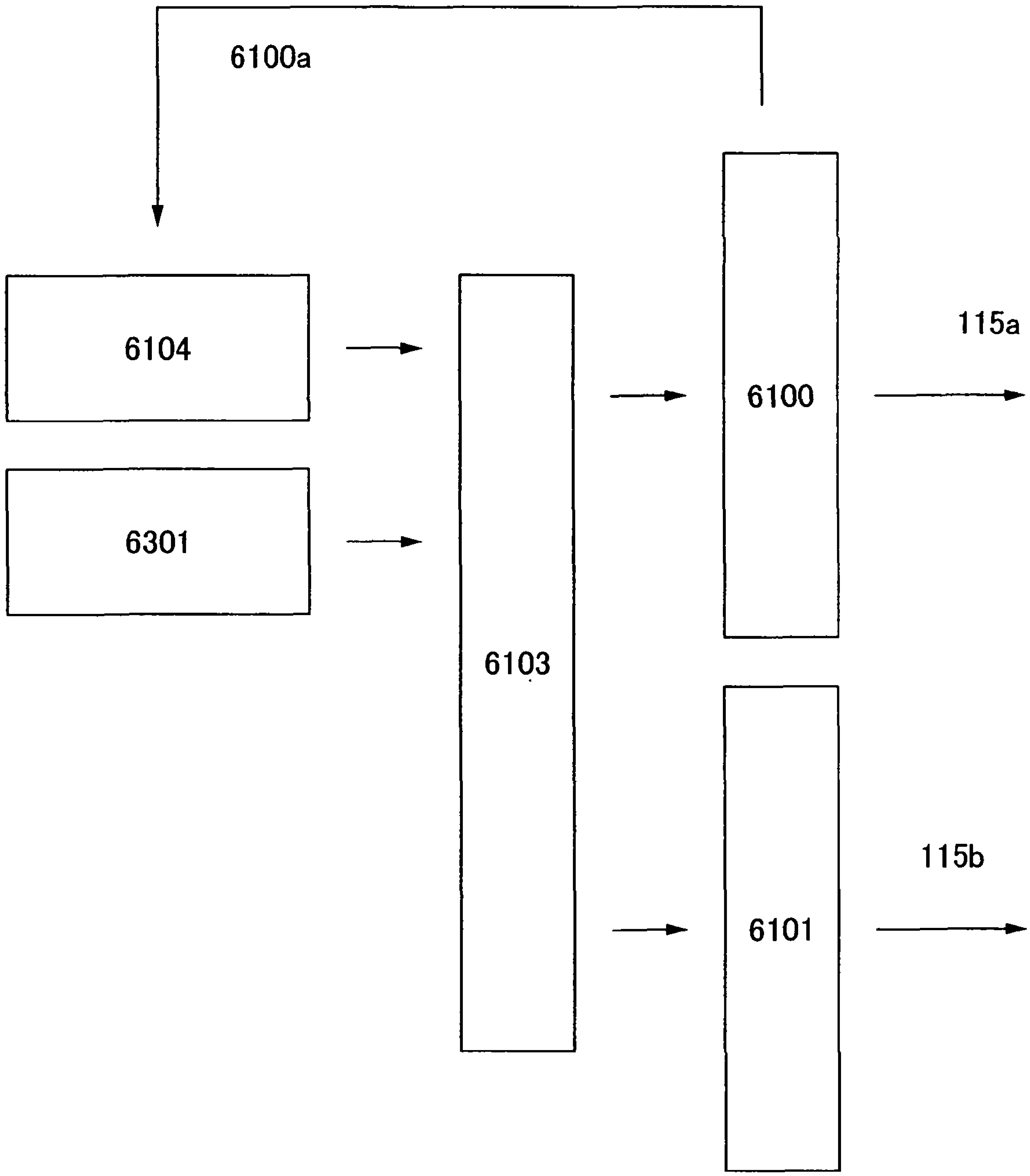


FIG. 64

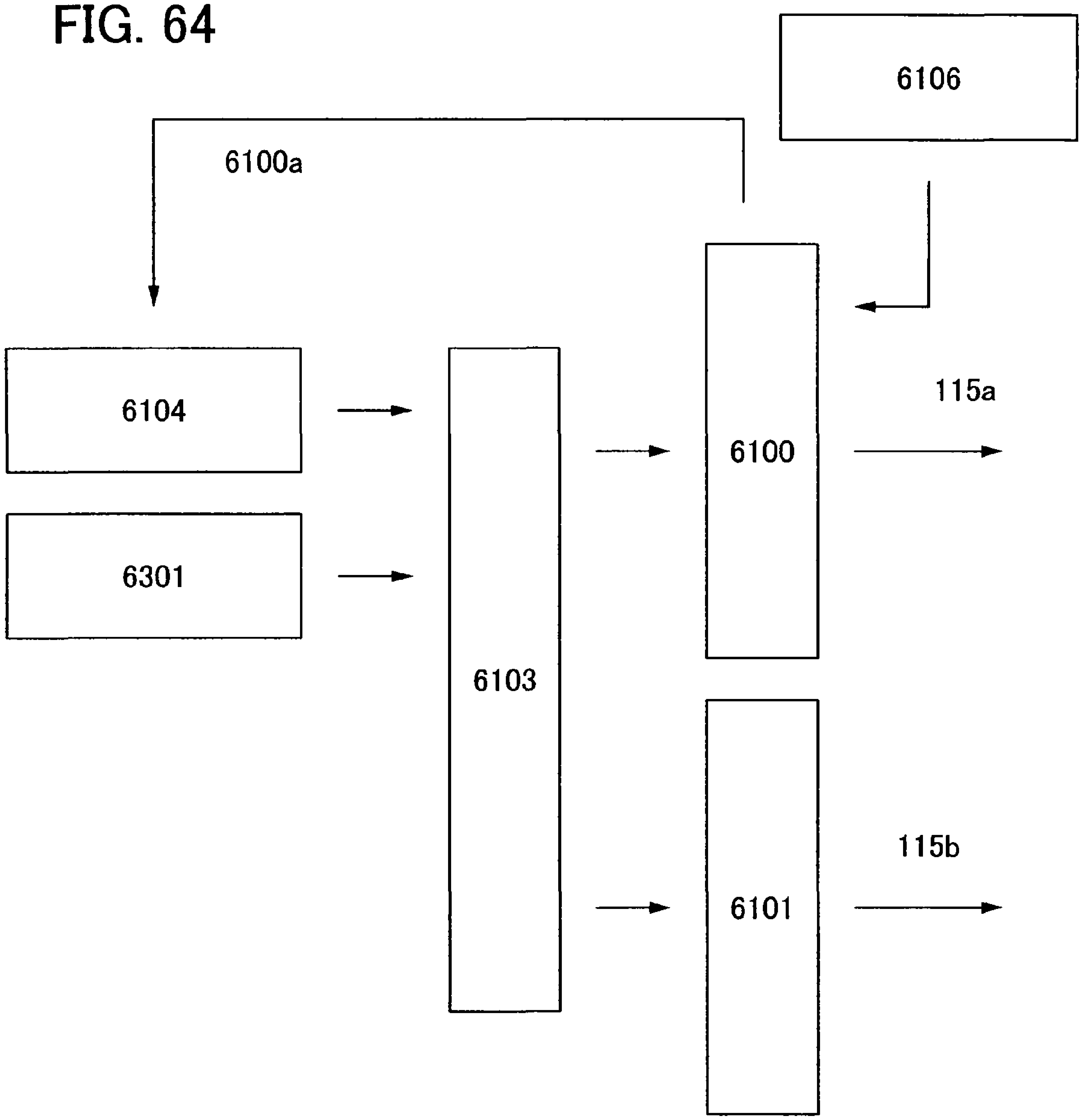


FIG. 65

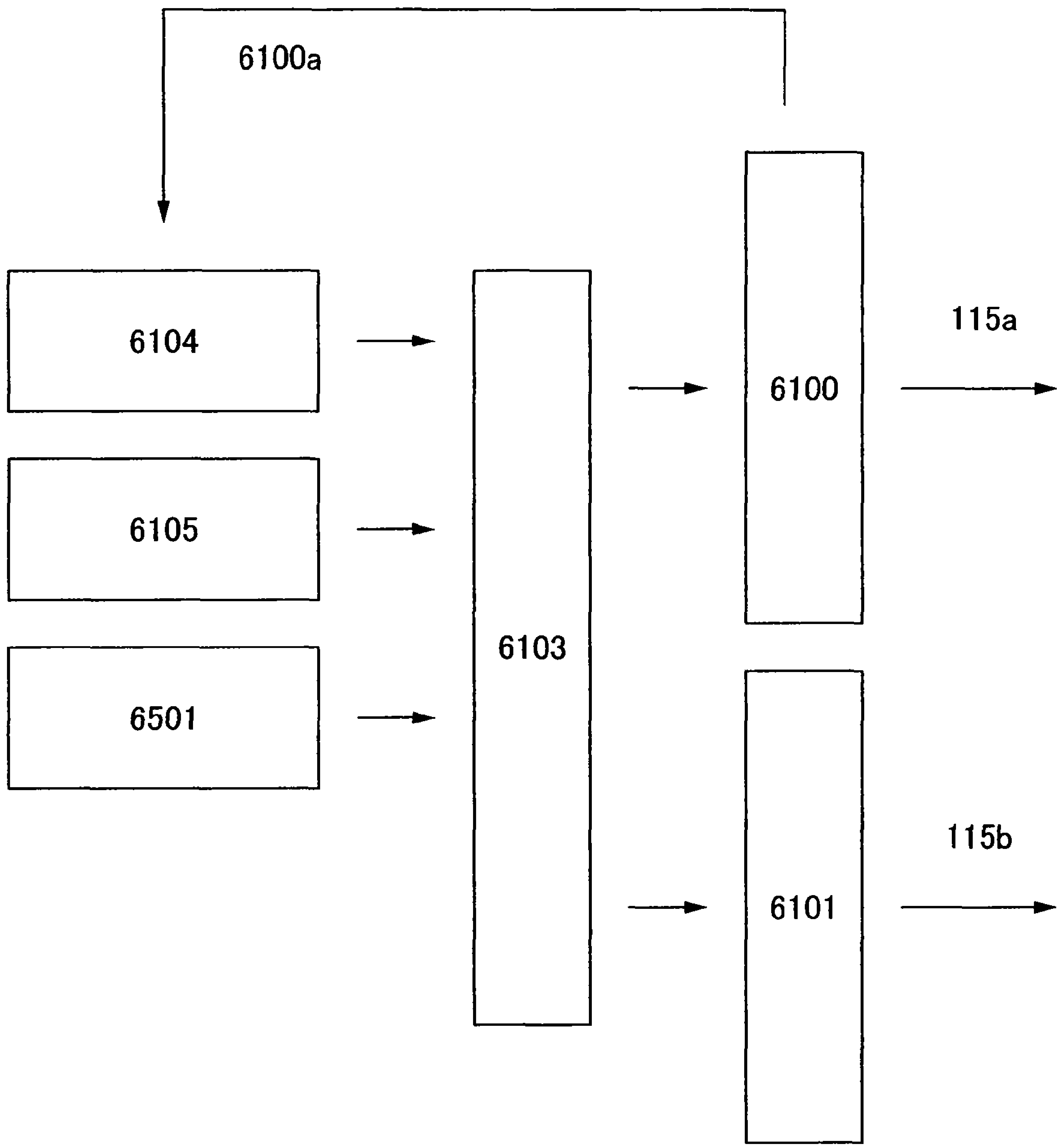


FIG. 66

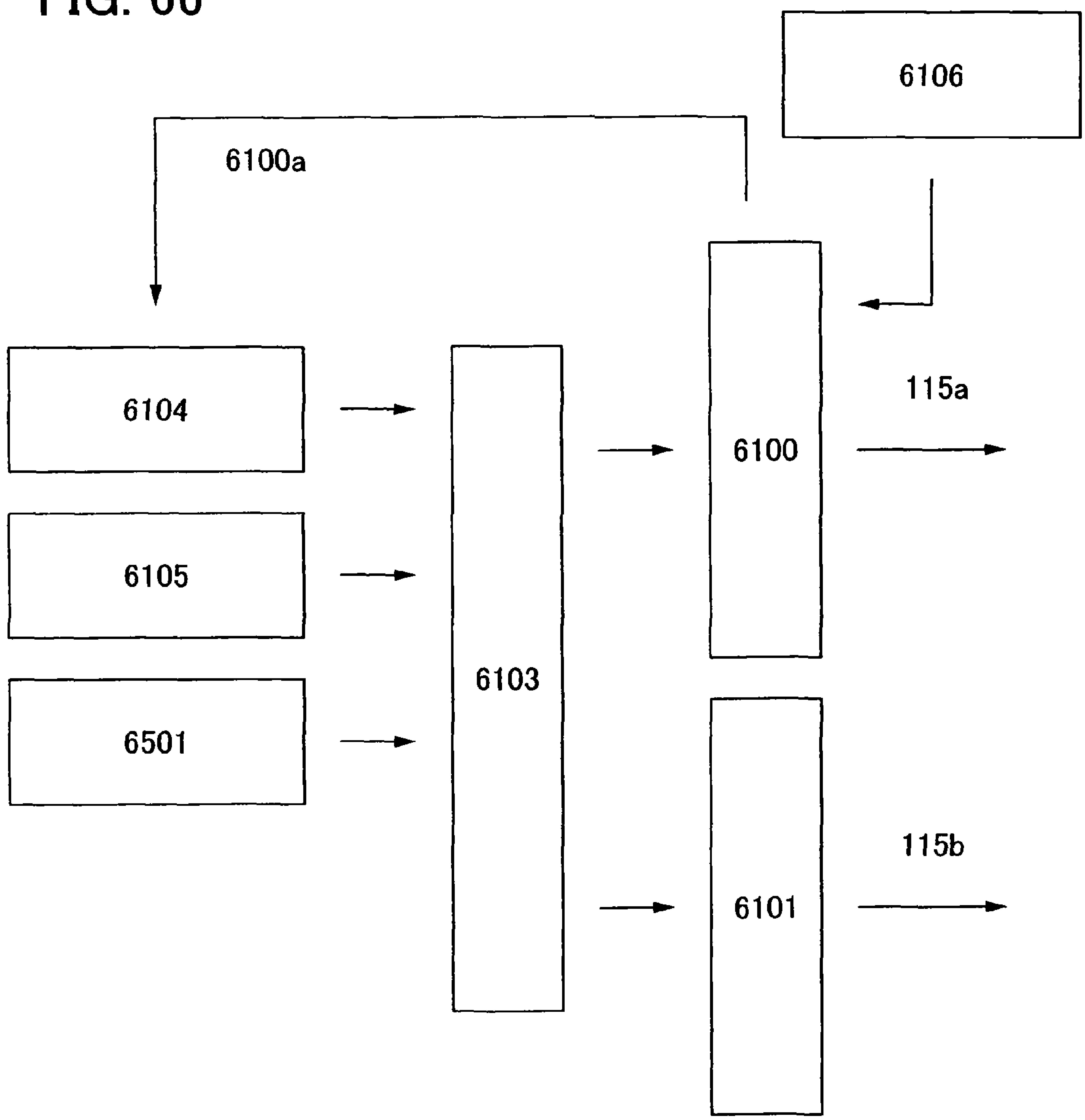


FIG. 67

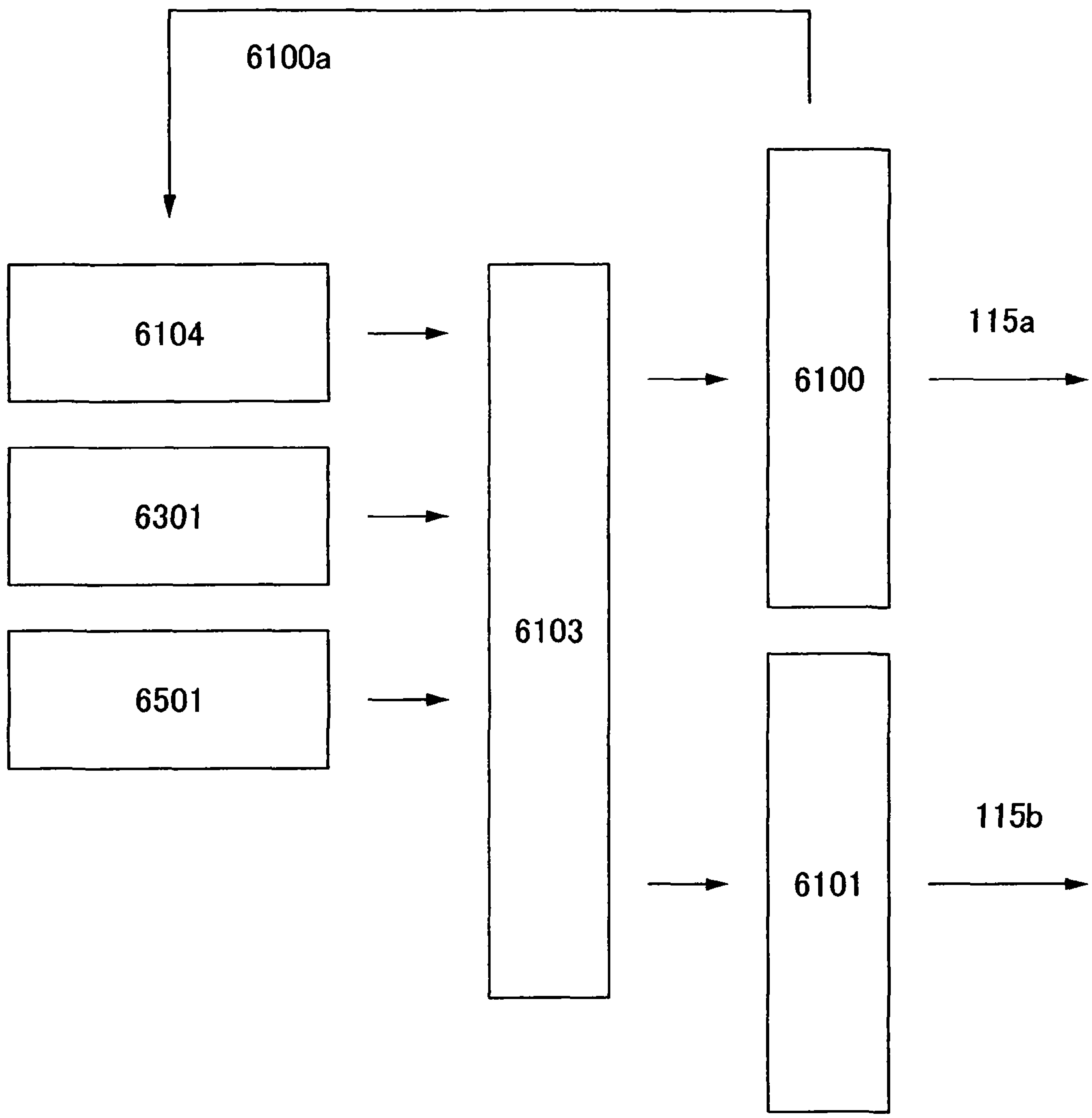


FIG. 68

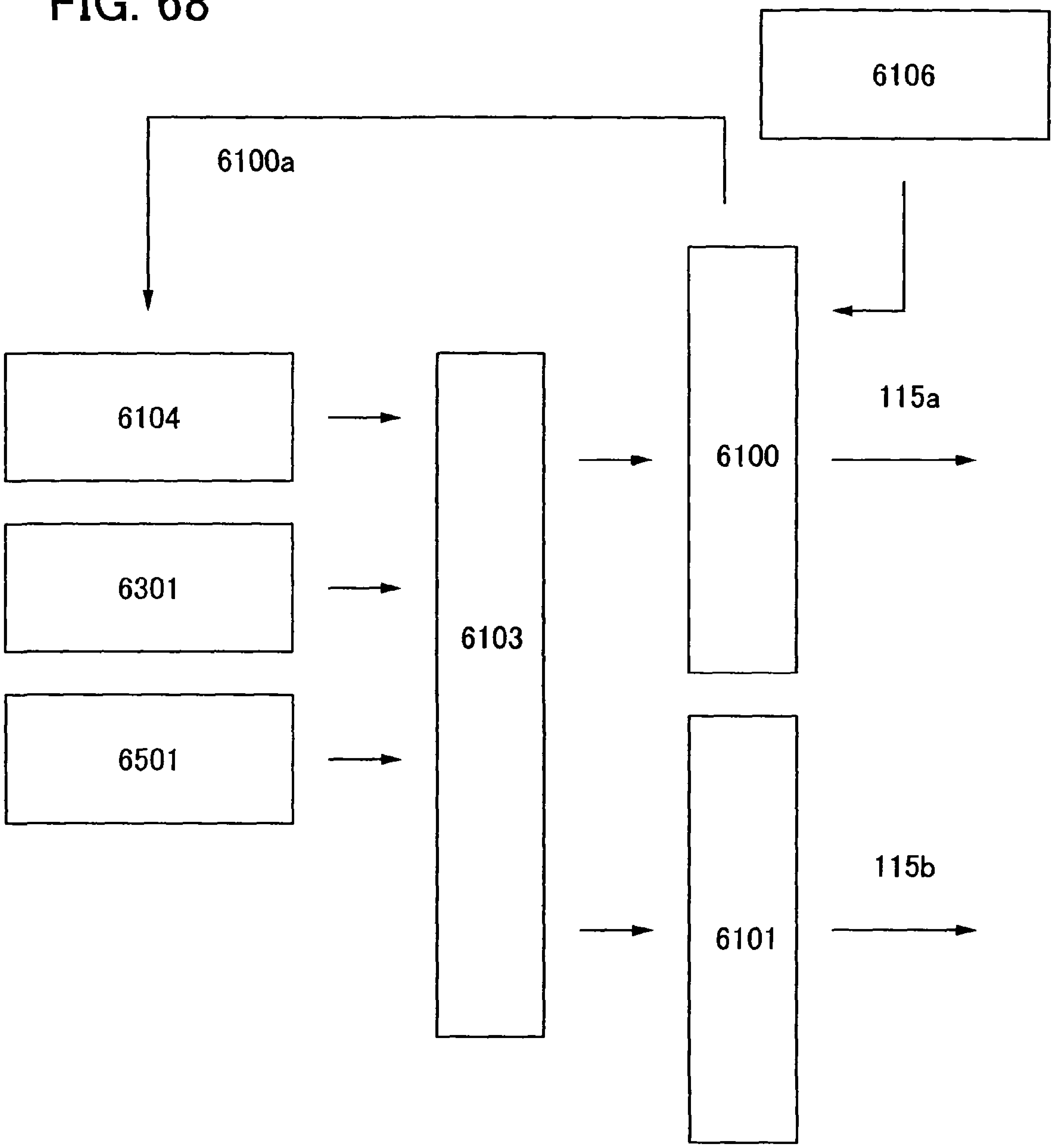


FIG. 69

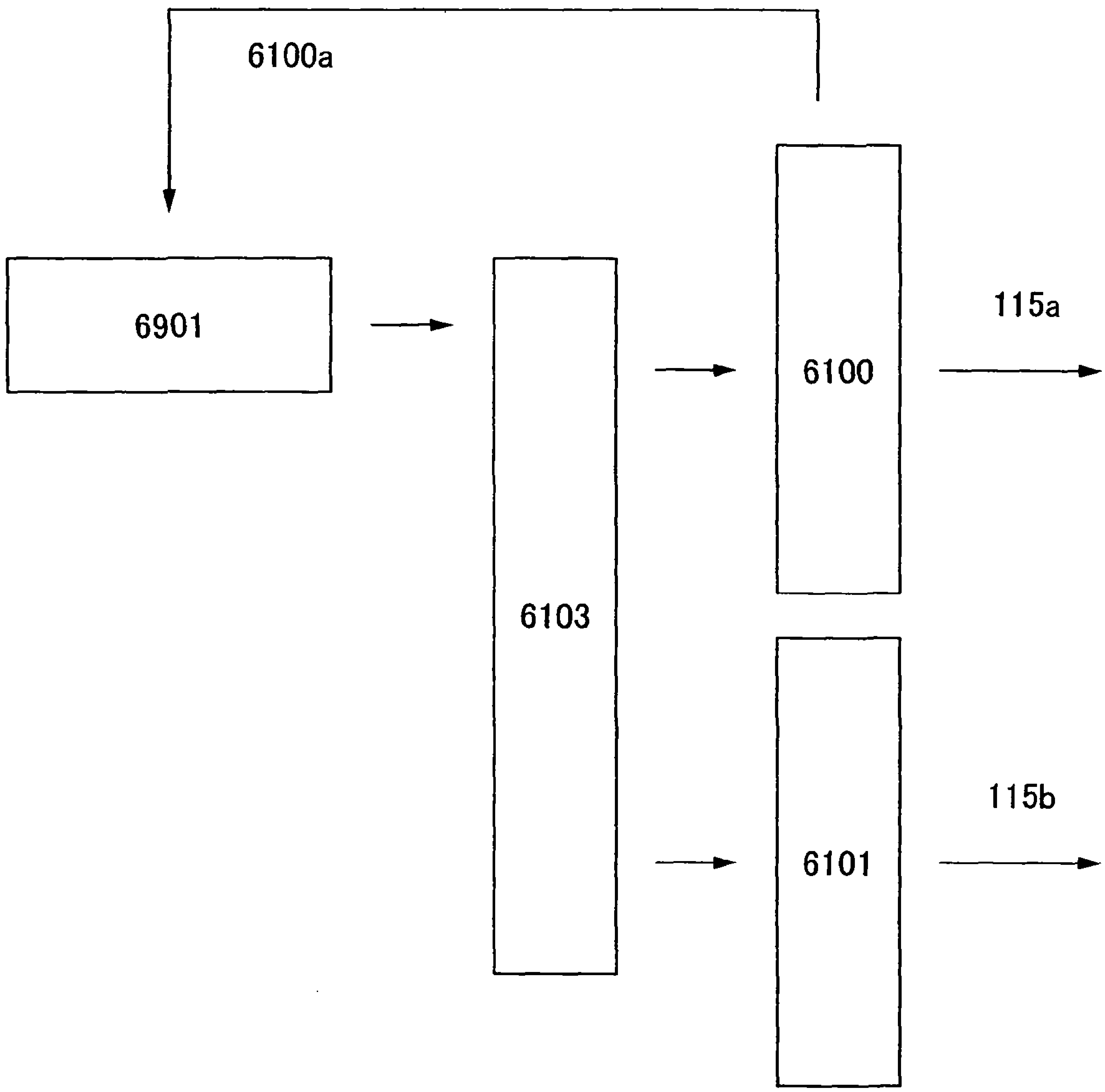


FIG. 70

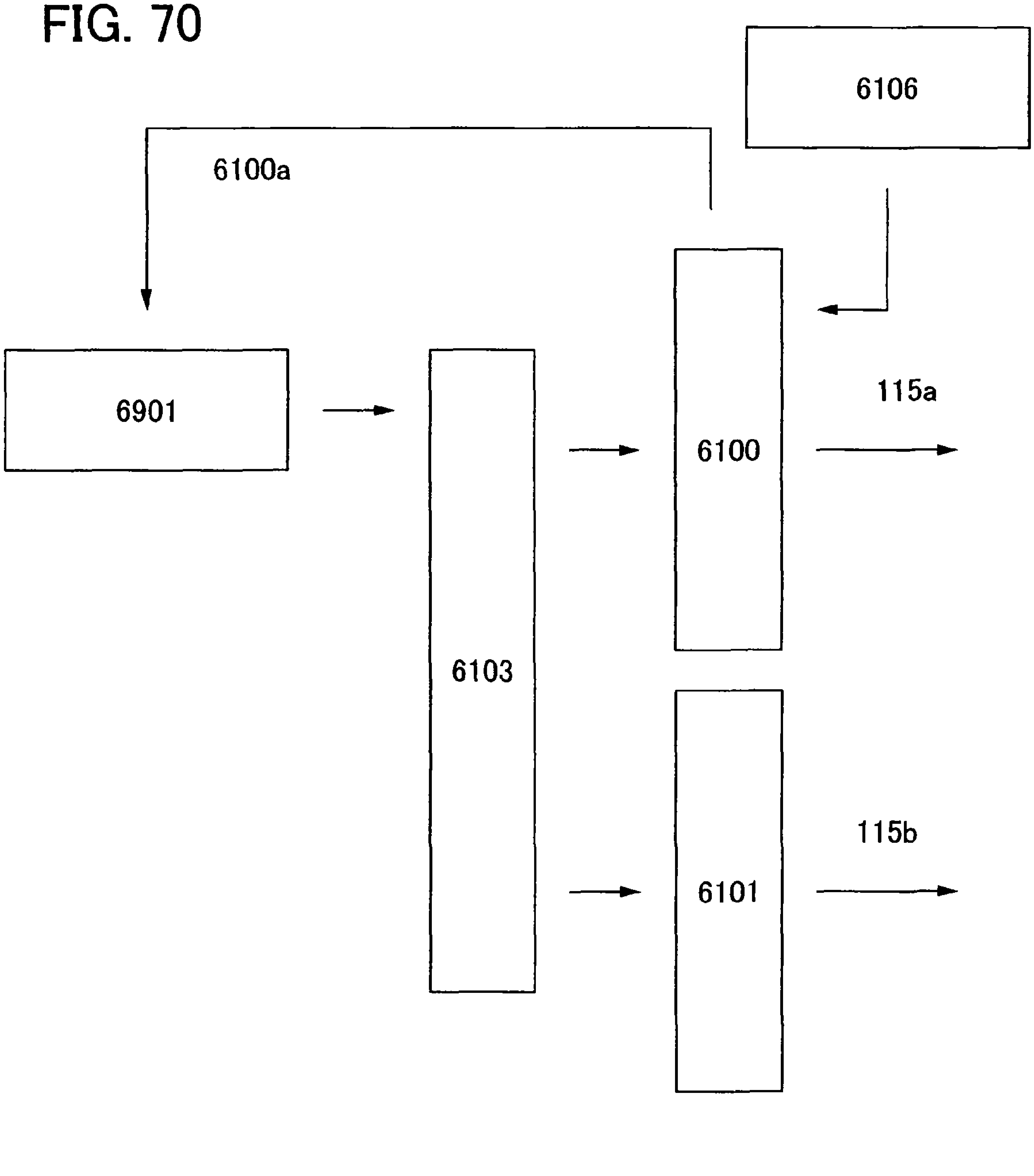


FIG. 71

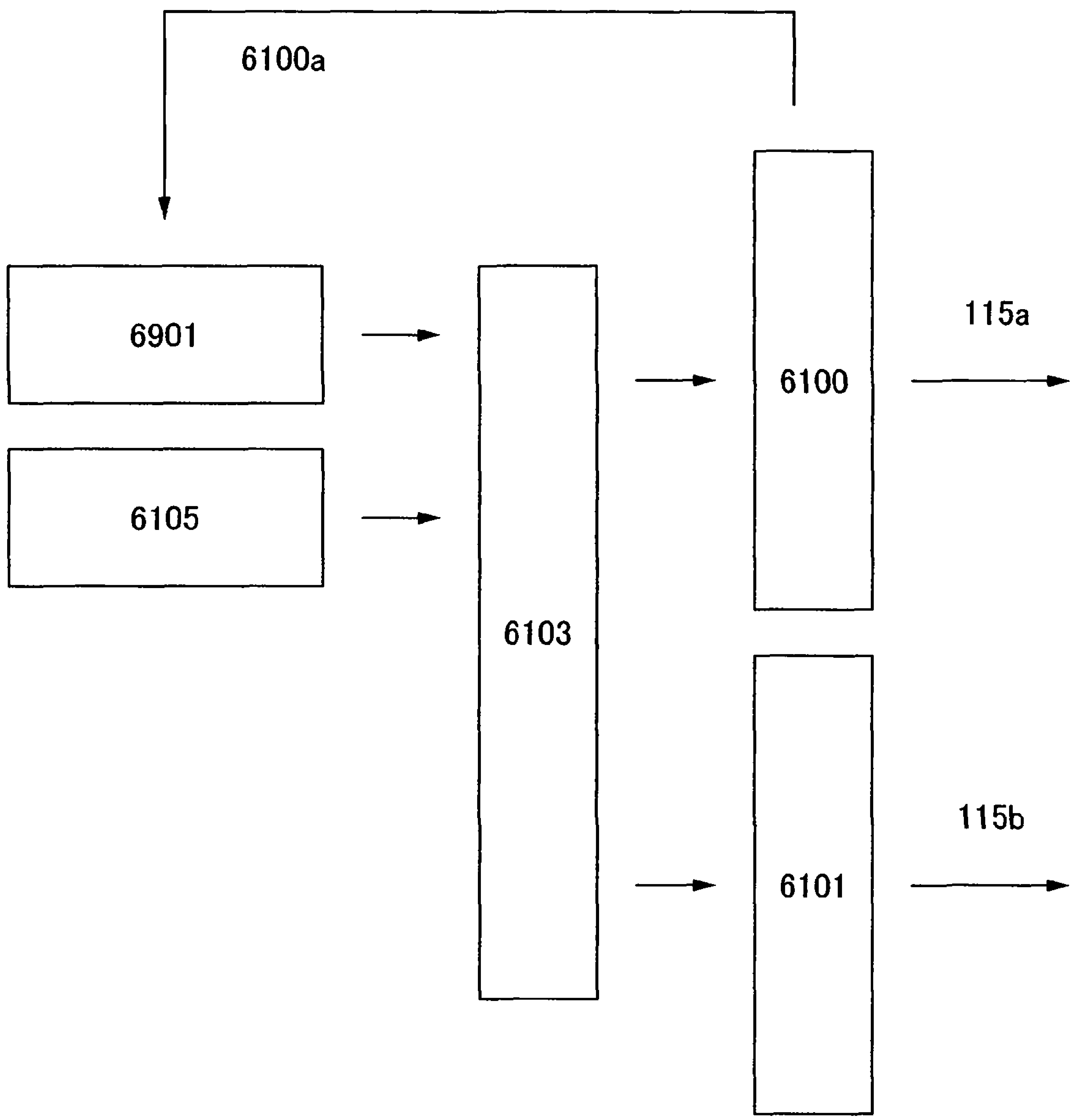


FIG. 72

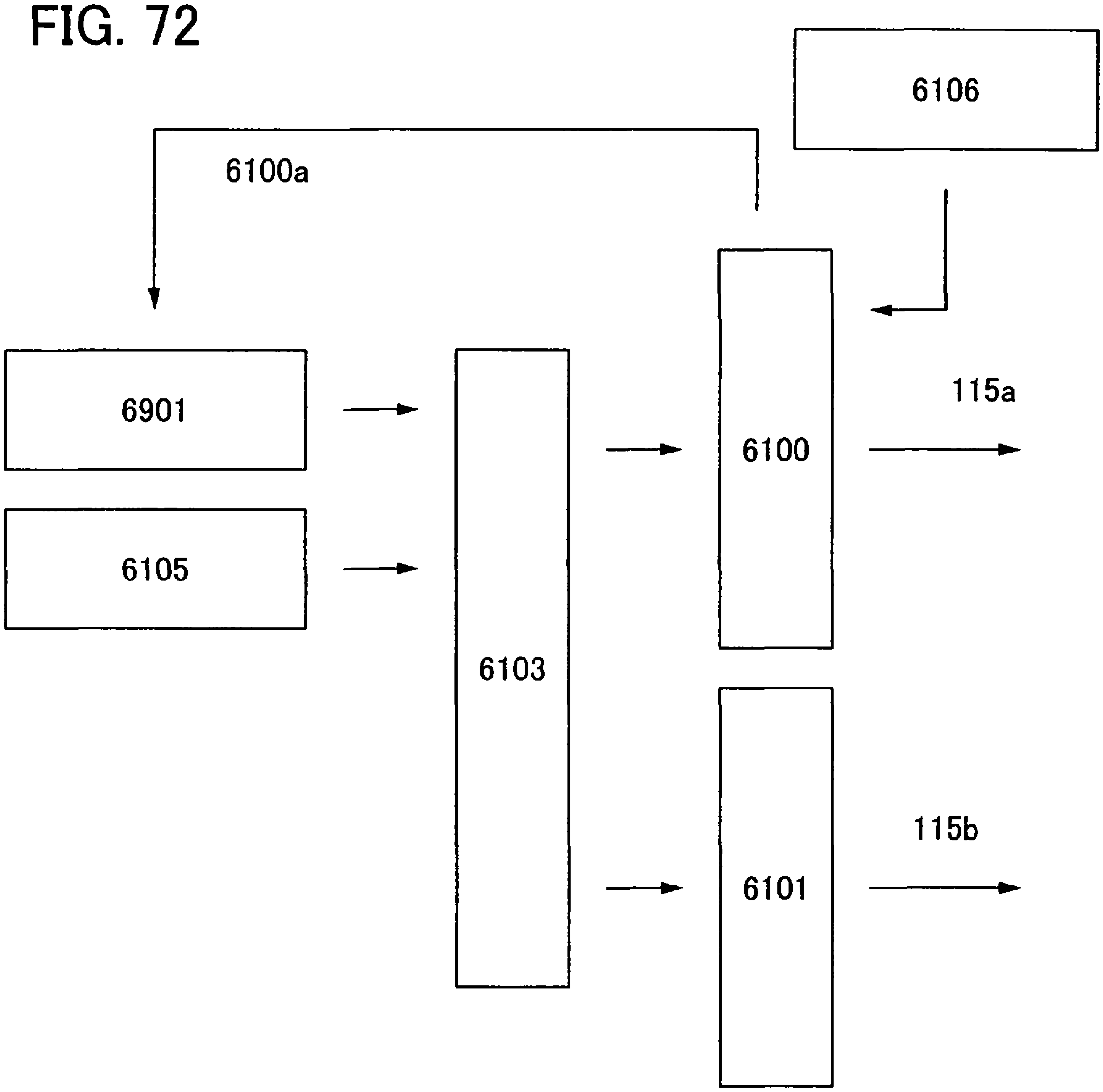


FIG. 73

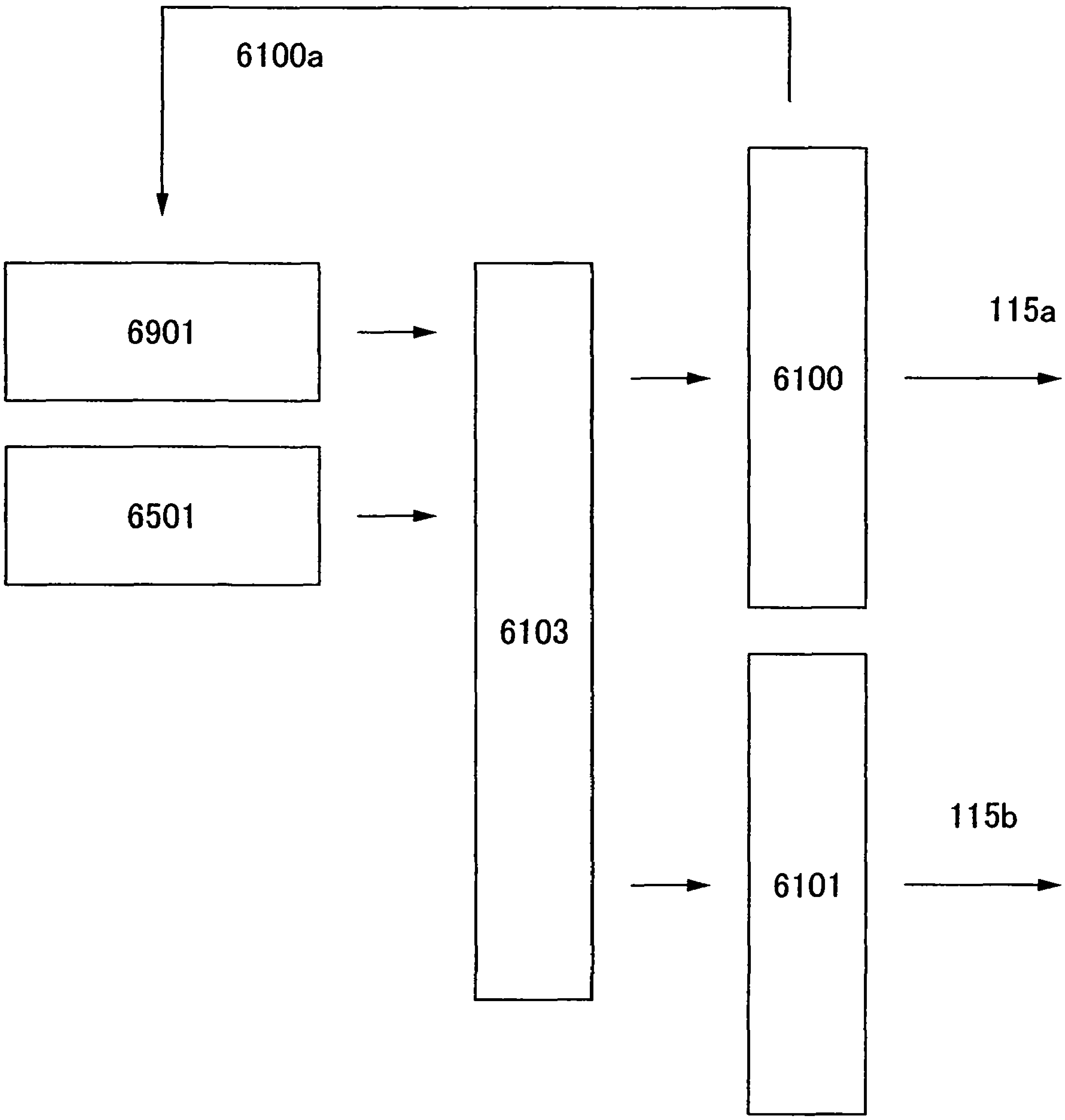


FIG. 74

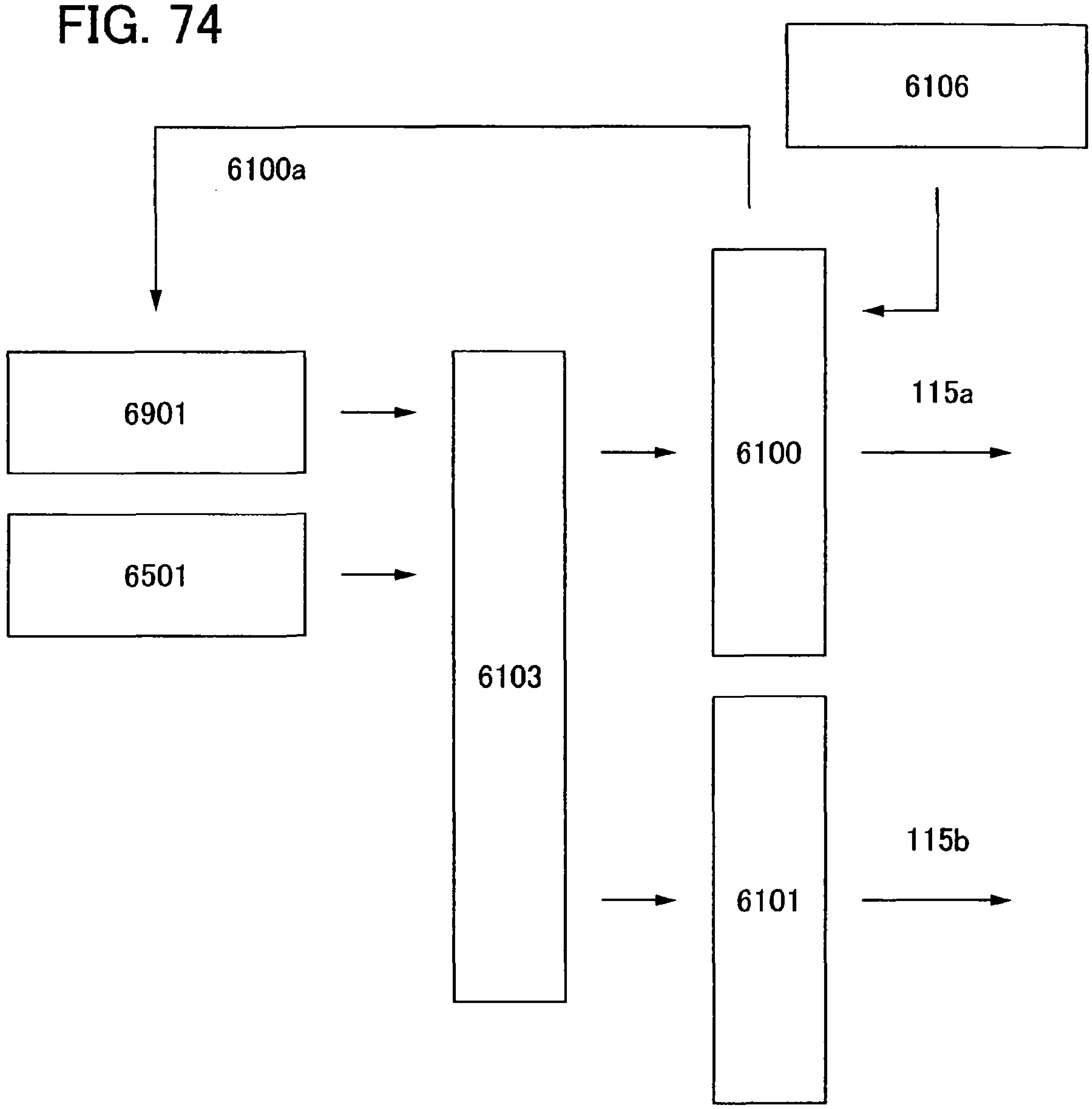


FIG. 75

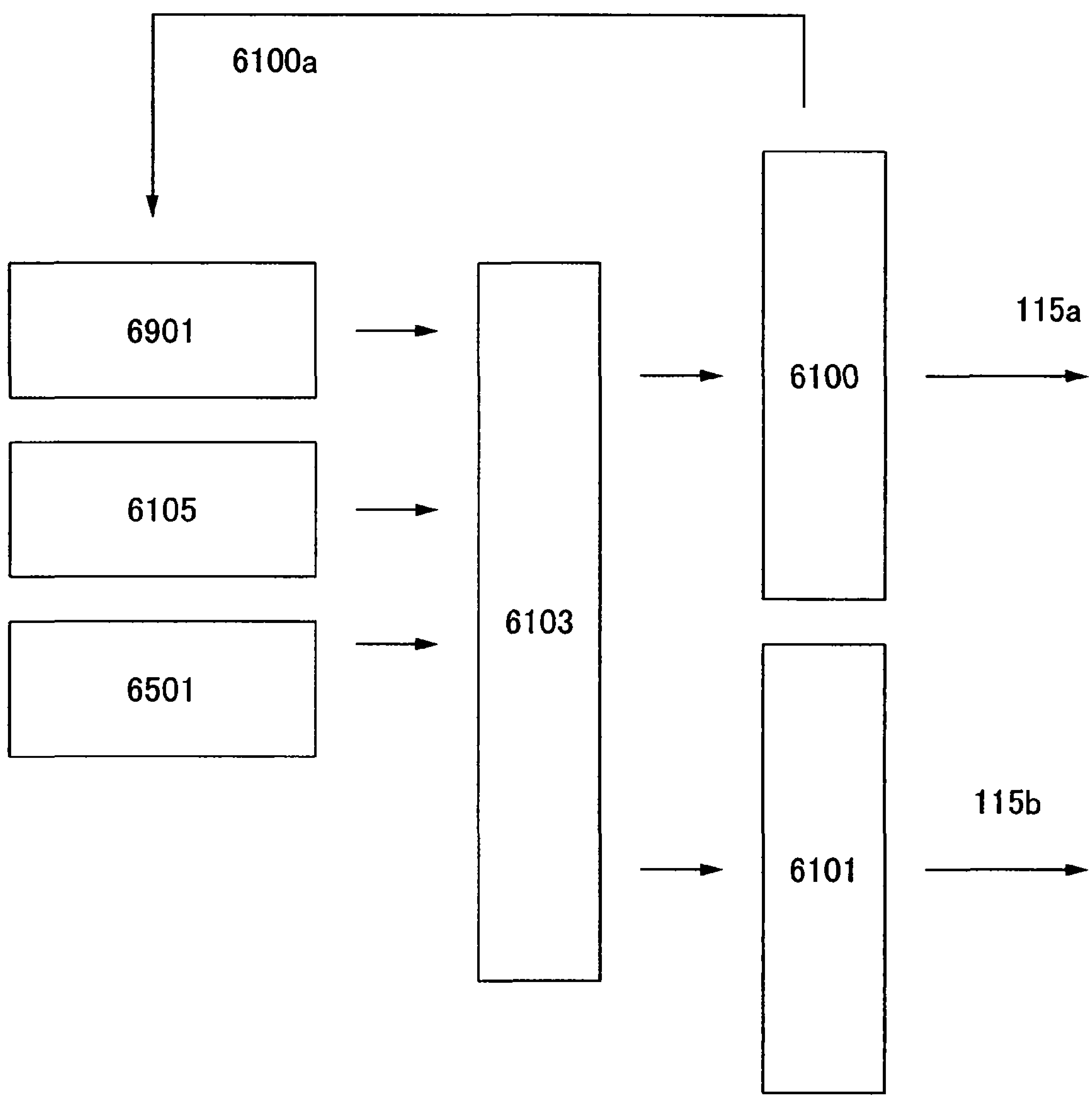


FIG. 76

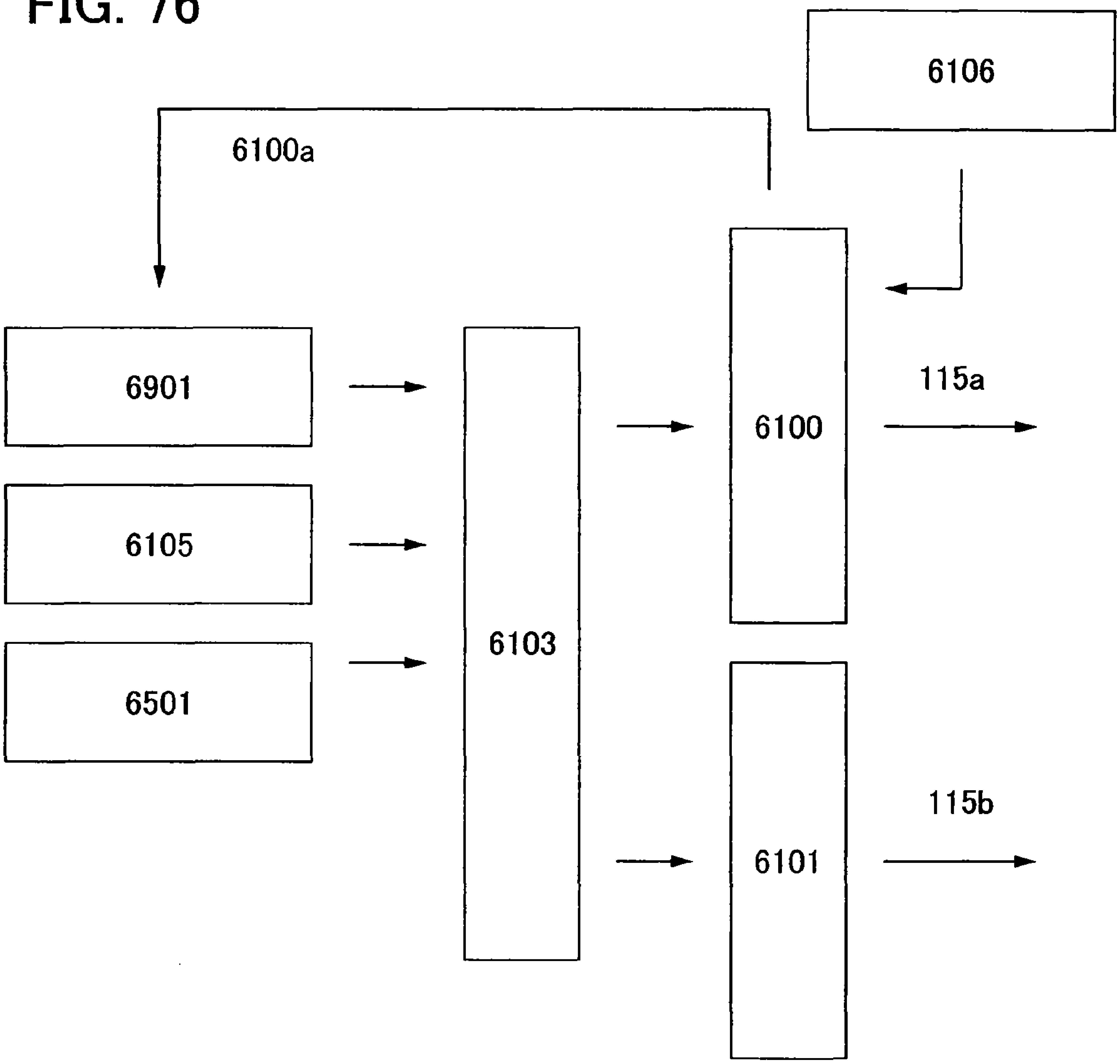


FIG. 77A

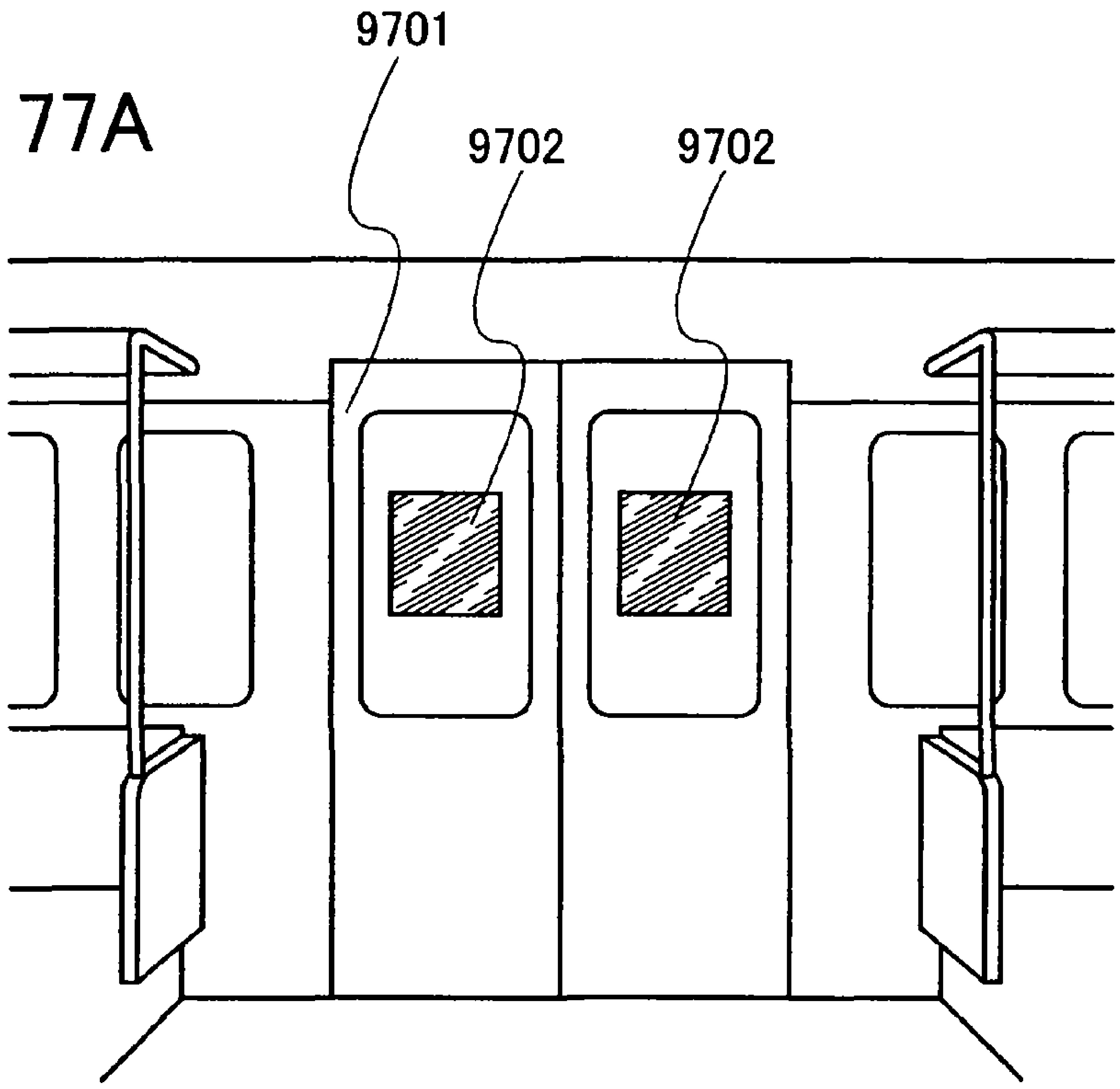


FIG. 77B

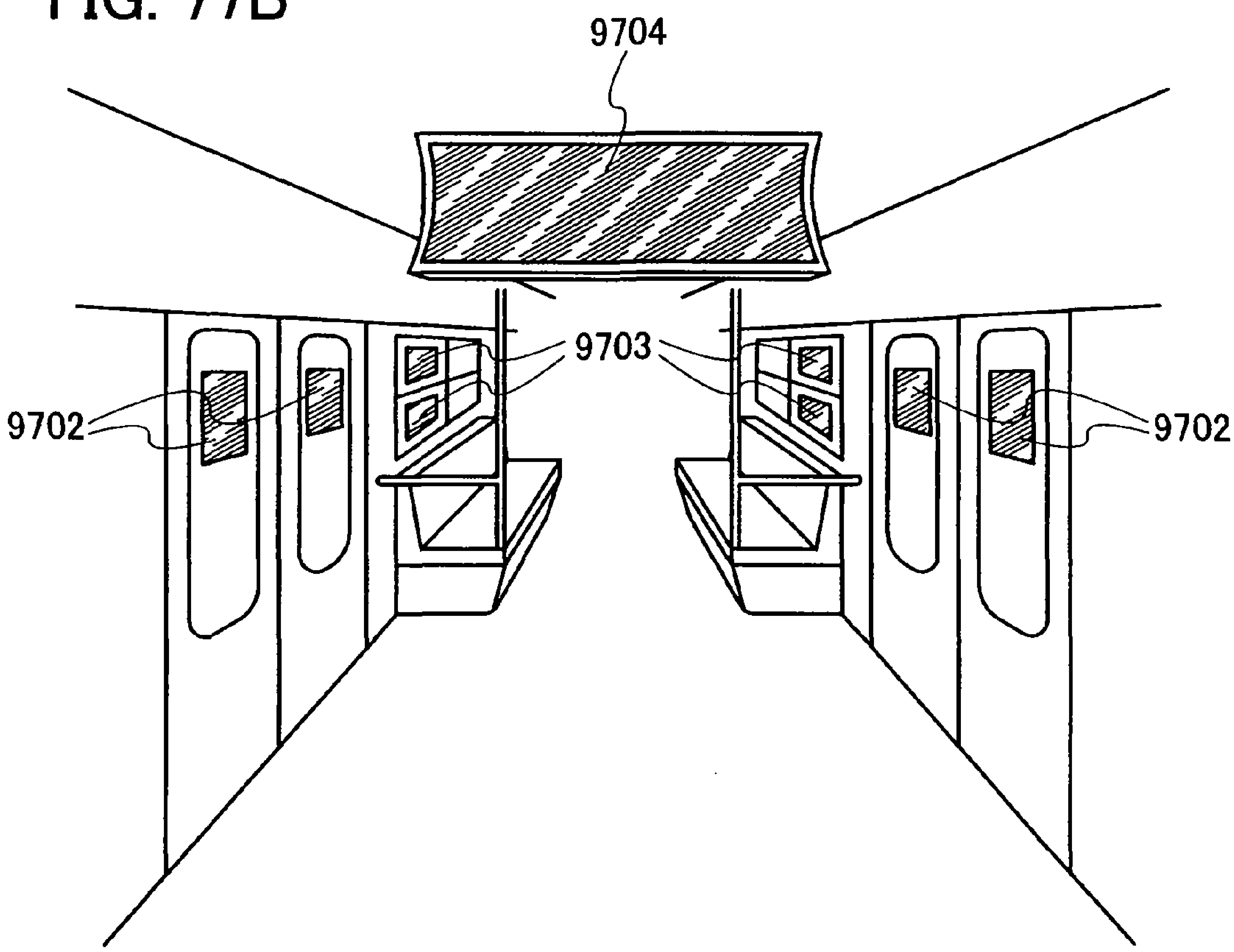


FIG. 78

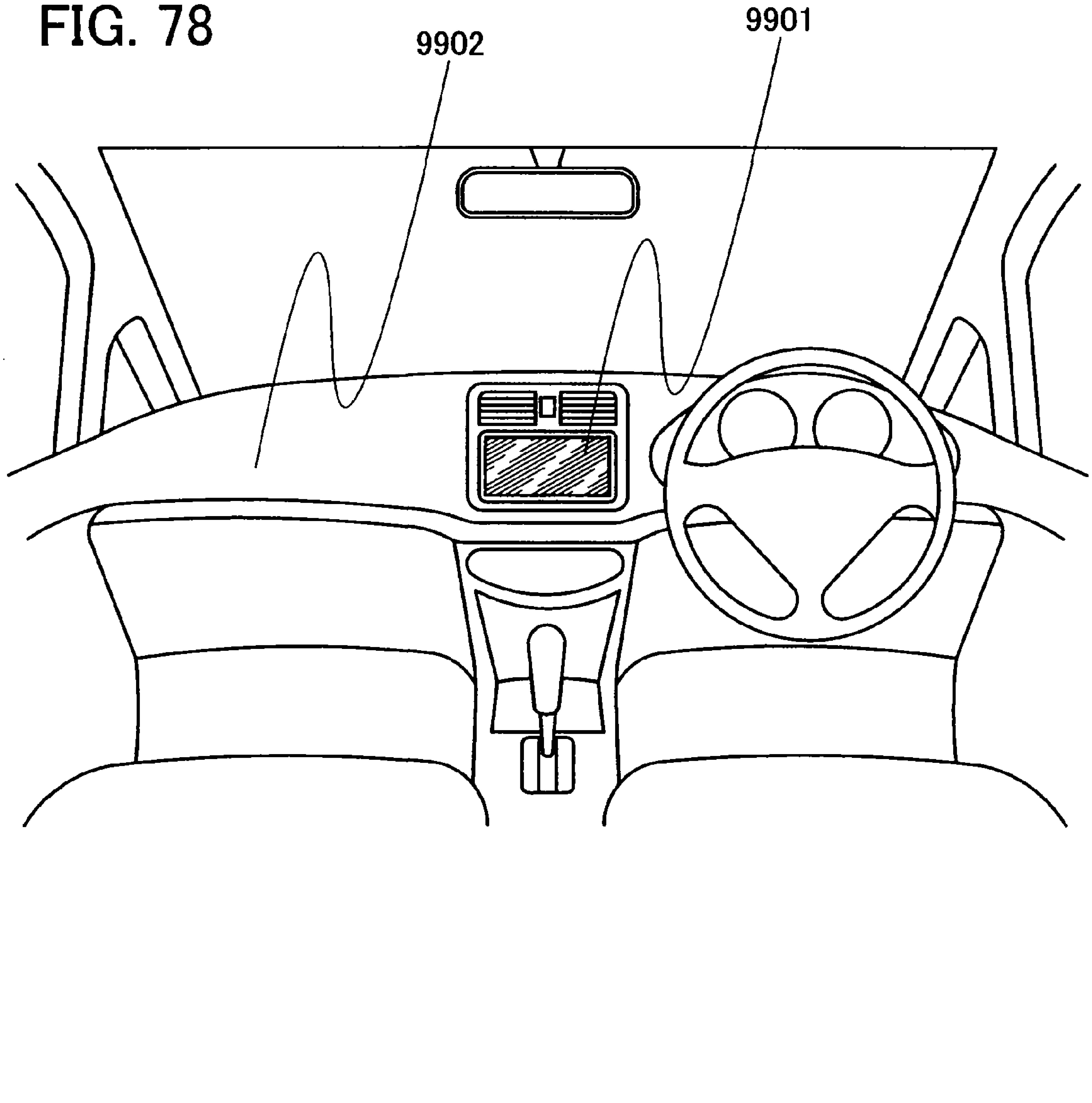


FIG. 79A

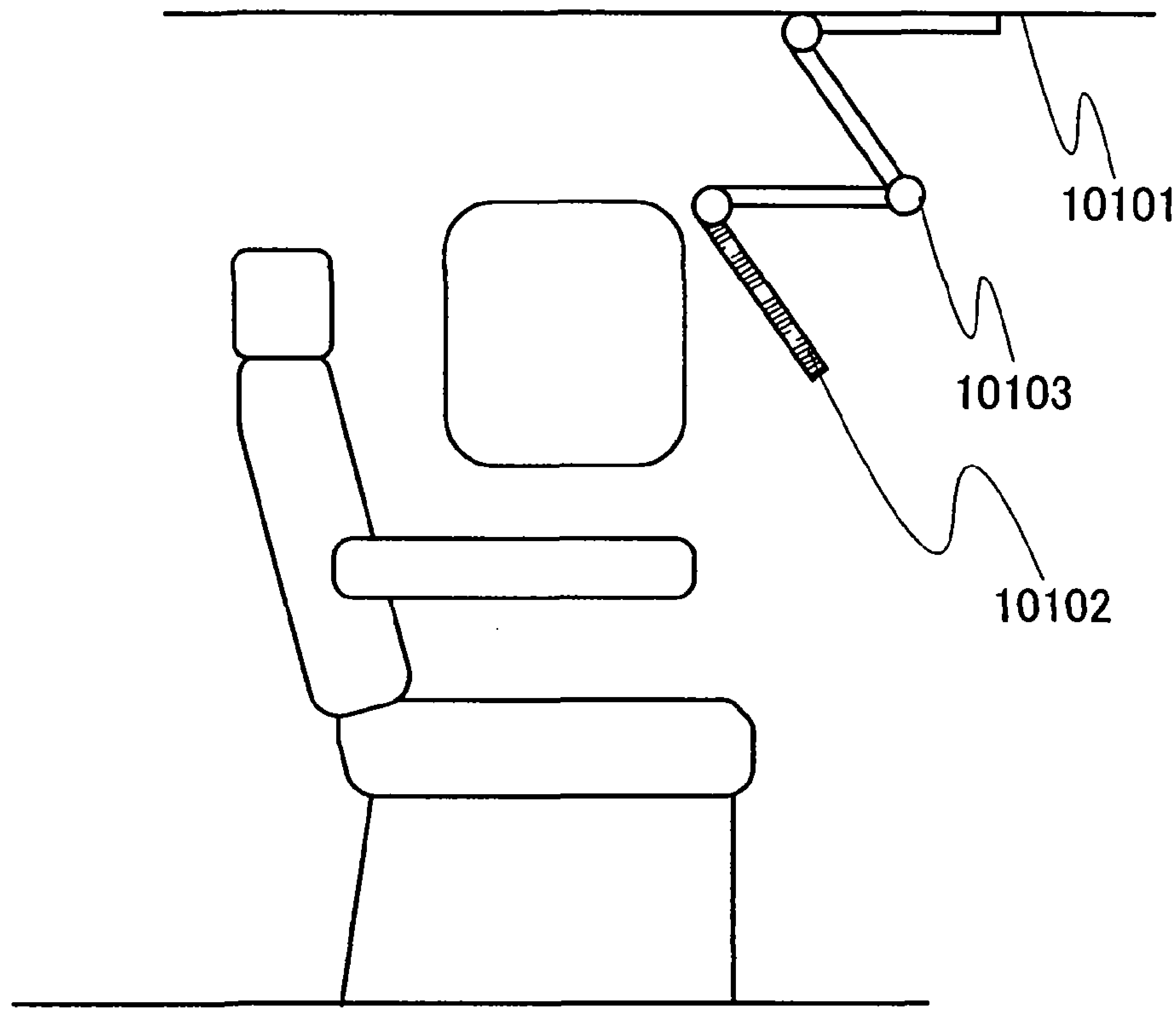


FIG. 79B

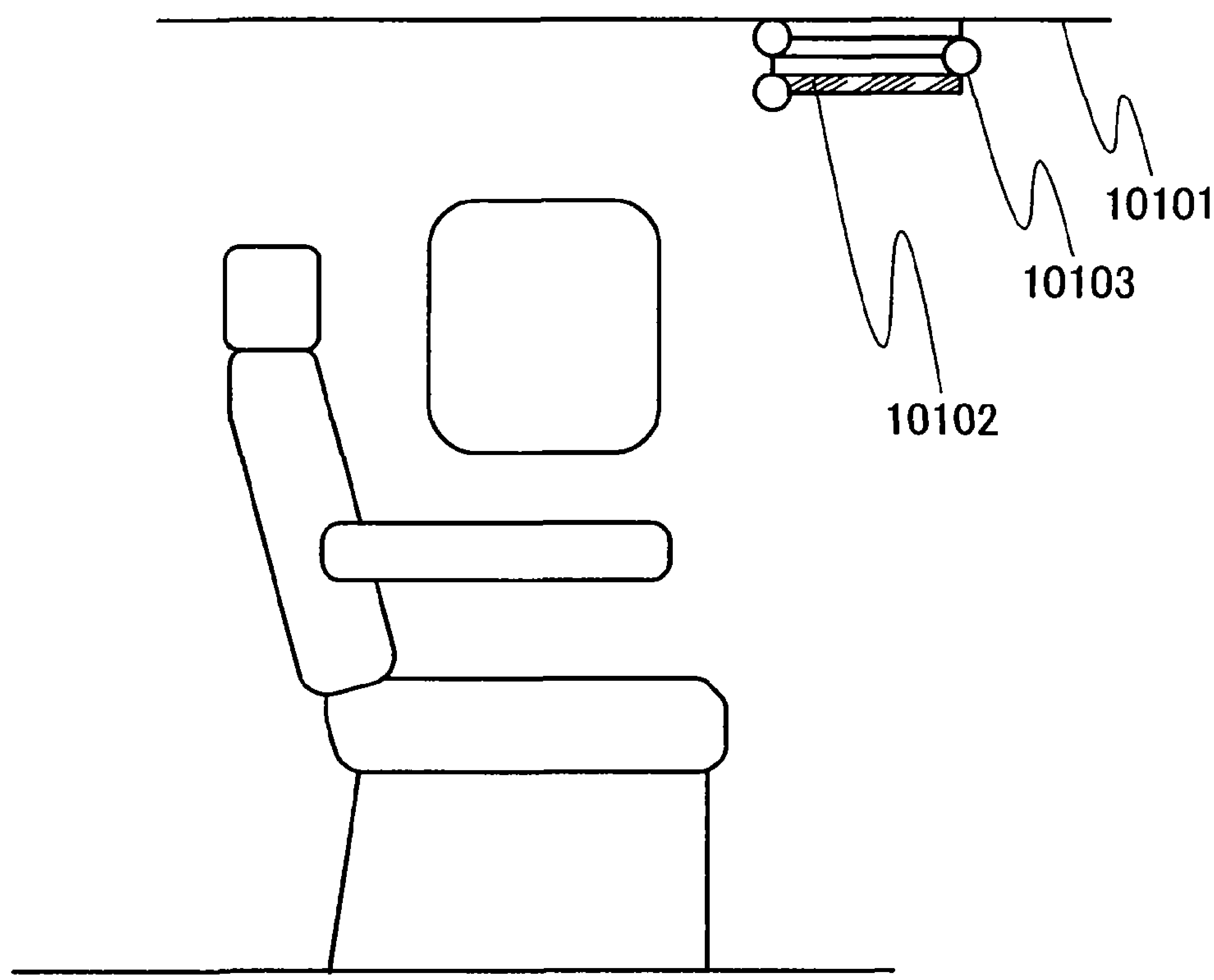


FIG. 80

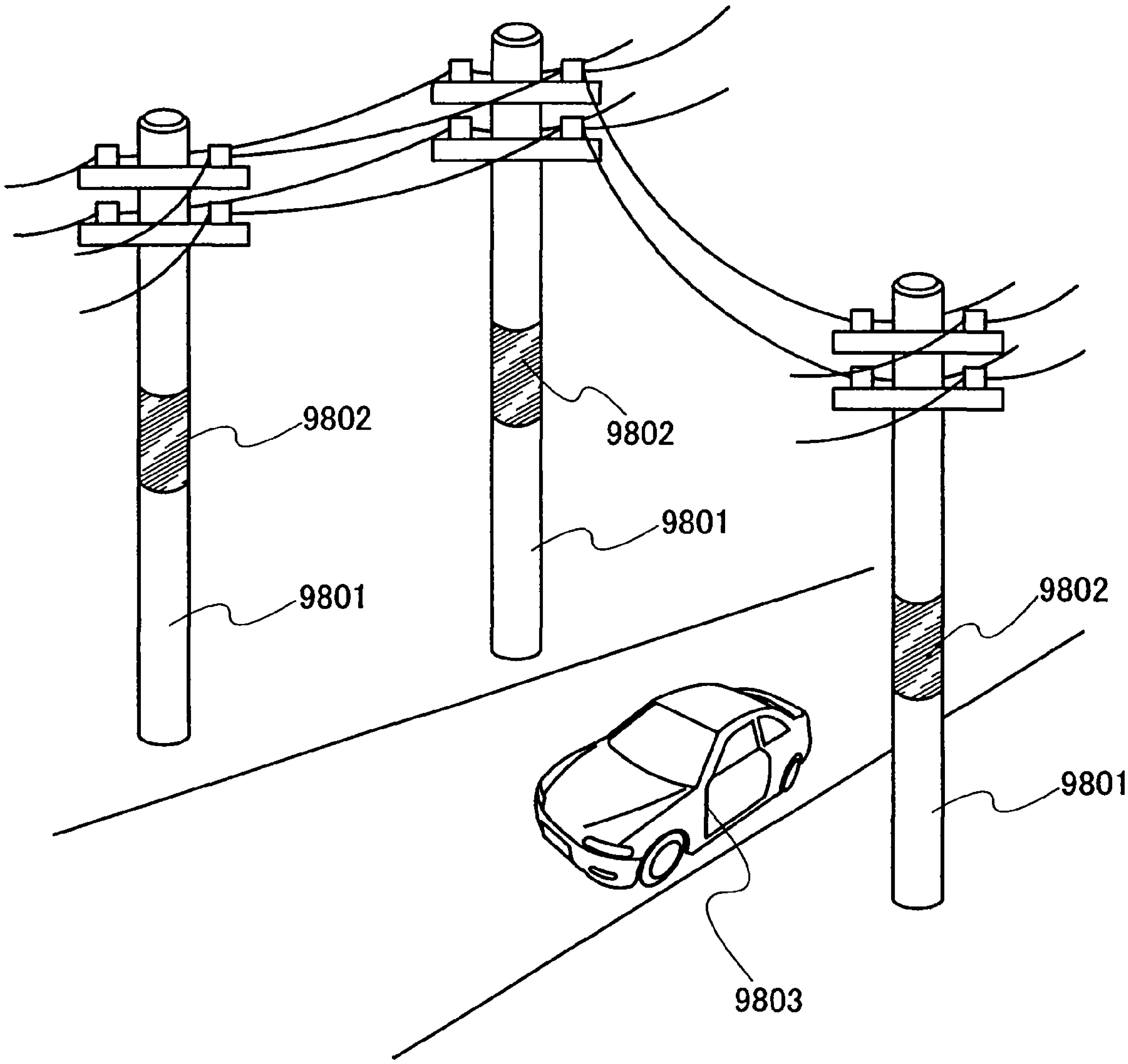


FIG. 81

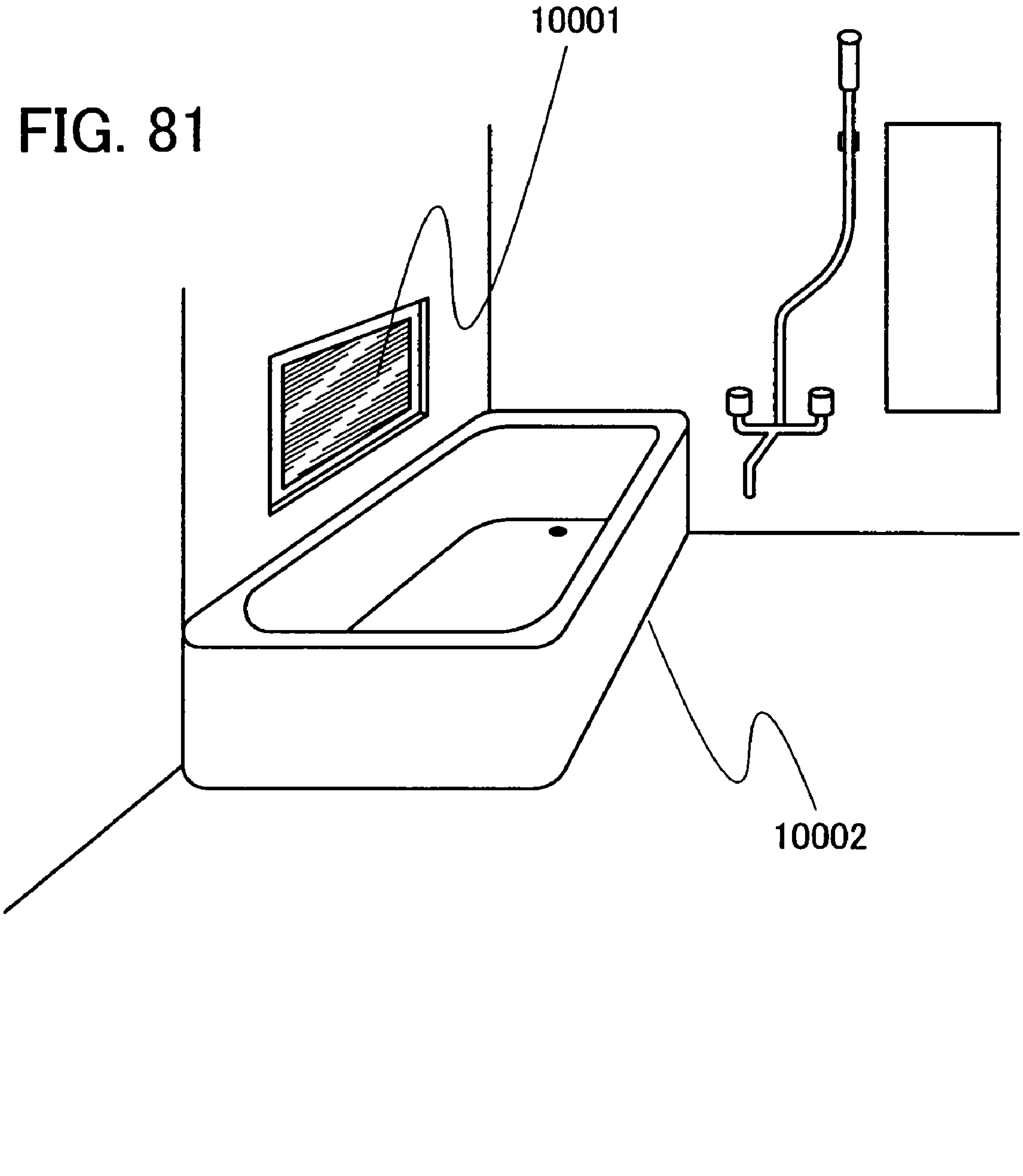
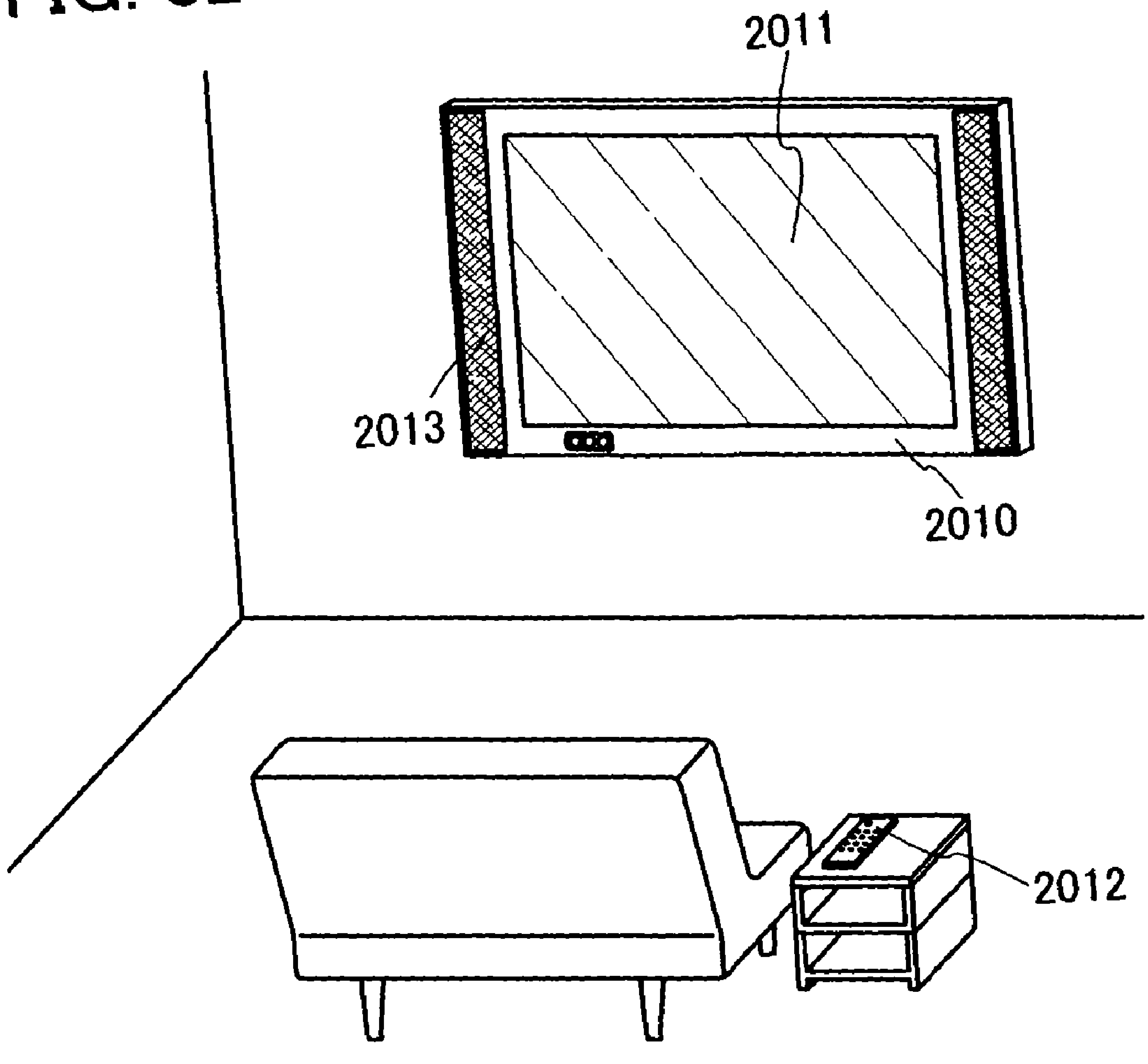


FIG. 82



DISPLAY DEVICE AND METHOD OF DRIVING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a display device including a transistor and method of driving the same. Specifically, the present invention relates to a display device having a pixel including a thin film transistor (hereinafter, also referred to as a TFT) and method of driving the same.

2. Description of the Related Art

In recent years, a thin display (also called a flat panel display) using an element which emits light with electrooptic property of liquid crystal or electroluminescence has attracted attention and the market thereof is expected to expand. A so-called active matrix display where pixels are formed with TFTs over a glass substrate have been regarded as important as a thin display. In particular, a TFT having a channel portion formed of a polycrystalline silicon film can achieve a high-speed operation since it has high electron field-effect mobility in comparison with a conventional TFT using an amorphous silicon film. Therefore, pixels can be controlled with a driver circuit which is formed by using TFTs over the same substrate as the pixels. A display in which pixels and various functional circuits using TFTs are formed over a glass substrate has various advantages such as reduction in the number of components, improvement in yield by a simplified manufacturing process, and improvement in productivity.

An active matrix display where electroluminescence elements (also referred to as OLED: Organic Light-Emitting Diode and hereinafter also called "EL element" or "light-emitting element" in this specification) and TFTs are combined has attracted attention as a thin and light display and has been actively studied within both domestic and international. Such a display is also called an organic EL display (OELD) and is examined to be developed to be in practical use as displays with various sizes, from a small size of 2 inches to a large size of over 40 inches.

In general, when an EL element deteriorates, current to voltage applied to the EL element flowing in the EL element is reduced. Current flowing in an EL element and luminance of the EL element are in a proportional relation; therefore reduction in current flowing in the EL element leads to reduction in luminance of the EL element. In addition, in an EL element, a voltage-current luminance characteristic deteriorates more than a current-luminance characteristic. For example, luminance of an EL element deteriorates early when fixed voltage is kept applying thereto compared with when fixed current is kept applying thereto. That is, deterioration in an EL element is easily caused when the EL element is driven in voltage compared to when the EL element is driven in current.

As a driving method for an active matrix EL display using an EL element as a display medium and having a structure in which the EL element and a TFT (hereinafter, also referred to as a driving TFT) are connected in series between two power supply lines, the following methods are known: a method in which a driving TFT operates in a saturation region to change voltage between a gate and source of the driving TFT, thereby controlling a current value flowing to the EL element, and a method in which a driving TFT operates in a linear region, thereby controlling time in which the EL element is supplied with voltage and emits light. In addition, in the driving method in which a driving TFT operates in a saturation region, a driving method in which time in which current flows to an EL element in a certain period is controlled, thereby displaying a gray scale is also known.

In the method in which a driving TFT operates in a leaner region, when the driving TFT is on, potentials of two power supply lines are applied almost as they are to an EL element. That is, the EL element is operated by voltage. As described above, luminance of an EL element deteriorates more when the EL element is operated by voltage compared with when the EL element is operated by current. Therefore, even when luminance of an EL element is the same, the luminance deteriorates more when a driving TFT is operated in a linear region compared with when the driving TFT is operated in a saturation region. Therefore, it can be said that burn-in is easily generated in an active matrix EL display in which a driving TFT is operated in a liner region compared with an active matrix EL display in which a driving TFT is operated in a saturation region.

To prevent bun-in in an active matrix EL display in which a driving TFT is operated in a linear region, a method is known in which deterioration conditions in all EL elements are measured and the EL elements are driven by video signals (see Patent Document 1). In this method, current values of EL elements supplied with certain voltage are measured in each pixel. When there is a deteriorated pixel with a low current value, video signals for the deteriorated pixel is corrected so as to obtain a predetermined current value, which means to obtain predetermined luminance.

[Patent Document 1] Japanese Patent Laid-Open No. 2003-195813

However, in a conventional art, a condition in which characteristics of light-emitting elements are detected is important since current flowing in a light-emitting element in each pixel is small (approximately several μA) when a pixel is formed with an EL element, which is a light-emitting element using a light-emitting medium containing an electroluminescence material. For example, if a detecting condition is different, characteristics of one light-emitting element change significantly and effect of a noise, which is an external factor, also changes significantly.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide specified conditions for detecting characteristics of a light-emitting element and to correct deterioration in the light-emitting element with further accuracy.

A display device of the present invention has a battery, a pixel including a light-emitting element, a timer circuit, a charging unit detection circuit, and a driving method selection circuit. The timer circuit outputs signals for proceeding to a next burn-in correction period when a predetermined time passes after an end of a burn-in correction period in which characteristics of the light-emitting element are obtained through a normal driving period in which an image is displayed. The charging unit detection circuit outputs signals for proceeding to the burn-in correction period when the battery is charged. The driving method selection circuit outputs signals for proceeding to the burn-in correction period from the normal driving period when the signals for proceeding to the burn-in correction period are inputted from both the timer circuit and the charging unit detection circuit, and for proceeding to the normal driving period from the burn-in correction period when any of these signals for proceeding to the burn-in correction period are not inputted.

A display device of the present invention has a pixel including a light-emitting element, a timer circuit, a non-operating detection circuit, and a driving method selection circuit. The timer circuit outputs signals for proceeding to a next burn-in correction period when a predetermined time passes after an end of a burn-in correction period in which characteristics of the light-emitting element are obtained through a normal driving period in which an image is displayed. The non-operating detection circuit outputs signals for proceeding to the burn-in correction period when the display device is not turned on for a predetermined time. The driving method selection circuit outputs signals for proceeding to the burn-in correction period from the normal driving period when the signals for proceeding to the burn-in correction period are inputted from both the timer circuit and the non-operating detection circuit, and for proceeding to the normal driving period from the burn-in correction period when any of these signals for proceeding to the burn-in correction period are not inputted.

A display device of the present invention has a battery, a pixel including a light-emitting element, a timer circuit, a charging unit detection circuit, a surrounding luminance detection circuit, and a driving method selection circuit. The timer circuit outputs signals for proceeding to a next burn-in correction period when a predetermined time passes after an end of a burn-in correction period in which characteristics of the light-emitting element are obtained through a normal driving period in which an image is displayed. The charging unit detection circuit outputs signals for proceeding to the burn-in correction period when the battery is charged. The surrounding luminance detection circuit outputs signals for proceeding to the burn-in correction period when surrounding luminance of the display device is close to predetermined luminance. The driving method selection circuit outputs signals for proceeding to the burn-in correction period from the normal driving period when the signals for proceeding to the burn-in correction period are inputted from all of the timer circuit, the charging unit detection circuit, and the surrounding luminance detection circuit and for proceeding to the normal driving period from the burn-in correction period when any of these signals for proceeding to the burn-in correction period are not inputted.

A display device of the present invention has a pixel including a light-emitting element, a timer circuit, a non-operating detection circuit, a surrounding luminance detection circuit, and a driving method selection circuit. The timer circuit outputs signals for proceeding to a next burn-in correction period when a predetermined time passes after an end of a burn-in correction period in which characteristics of the light-emitting element are obtained through a normal driving period in which an image is displayed. The non-operating detection circuit outputs signals for proceeding to the burn-in correction period when the display device is not turned on for a predetermined time. The surrounding luminance detection circuit outputs signals for proceeding to the burn-in correction period when surrounding luminance of the display device is close to predetermined luminance. The driving method selection circuit outputs signals for proceeding to the burn-in correction period from the normal driving period when the signals for proceeding to the burn-in correction period are inputted from all of the timer circuit, the non-operating detection circuit, and the surrounding luminance detection circuit, and for proceeding to the normal driving period from the burn-in correction period when any of these signals for proceeding to the burn-in correction period are not inputted.

A display device of the present invention has a pixel including a light-emitting element, a timer circuit, and a driving method selection circuit. The timer circuit outputs signals for proceeding to a next burn-in correction period when a predetermined time passes after an end of a burn-in correction period in which characteristics of the light-emitting element are obtained through a normal driving period in which an image is displayed. The driving method selection circuit outputs signals for proceeding to the burn-in correction period from the normal driving period when the signals for proceeding to the burn-in correction period are inputted from the timer/start circuit, and for proceeding to the normal driving period from the burn-in correction period when the signals for proceeding to the burn-in correction period are not inputted.

A display device of the present invention has a battery, a pixel including a light-emitting element, a start circuit, a charging unit detection circuit, and a driving method selection circuit. The start circuit can select a normal driving period in which an image is displayed or a burn-in correction period in which characteristic of the light-emitting element is obtained, and which outputs a first signal for proceeding to the burn-in correction period when proceeding to the burn-in correction period is selected. The charging unit detection circuit outputs signals for proceeding to the burn-in correction period when the battery is charged. The driving method selection circuit outputs signals for proceeding to the burn-in correction period from the normal driving period when the signals for proceeding to the burn-in correction period are inputted from both the start circuit and the charging unit detection circuit, and for proceeding to the normal driving period from the burn-in correction period when any of these signals for proceeding to the burn-in correction period are not inputted.

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A display device of the present invention has a battery, a pixel including a light-emitting element, a start circuit, a charging unit detection circuit, a surrounding luminance detection circuit, and a driving method selection circuit. The start circuit can select a normal driving period in which an image is displayed or a burn-in correction period in which characteristic of the light-emitting element is obtained, and which outputs a first signal for proceeding to the burn-in correction period when proceeding to the burn-in correction period is selected. The charging unit detection circuit outputs signals for proceeding to the burn-in correction period when the battery is charged. The surrounding luminance detection circuit outputs signals for proceeding to the burn-in correction period when surrounding luminance of the display device is close to predetermined luminance. The driving method selection circuit outputs signals for proceeding to the burn-in correction period from the normal driving period when the signals for proceeding to the burn-in correction period are inputted from all of the start circuit, the charging unit detection circuit, and a surrounding luminance detection circuit, and for proceeding to the normal driving period from the burn-in correction period when any of these signals for proceeding to the burn-in correction period are not inputted.

In the burn-in correction period, the characteristics of a light-emitting element included in each pixel are obtained by detecting current flowing to a counter electrode, which is an electrode of the light-emitting element and is a common electrode in the light-emitting element, the characteristic of a light-emitting element in each pixel are obtained by detecting current flowing in a power supply line, which is the other electrode of the light-emitting element, or the characteristic of a light-emitting element in a pixel in a region in which deterioration of the characteristics is supposed to be easily generated are obtained preferentially.

A potential of the counter electrode in the burn-in correction period is the same as that of the counter electrode in the normal driving period. A potential of the power supply line in the burn-in correction period is the same as that of the power supply line in the normal driving period. Driving frequency in the burn-in correction period is the same as that of the normal driving period.

Various switches can be used as a switch used in the present invention. As an example, there is an electrical switch, a mechanical switch, or the like. That is, as long as current flow can be controlled, the invention is not limited to a particular switch and various switches can be used. For example, the switch may be a transistor, a diode (such as a PN diode, a PIN diode, a Schottky diode, or a diode-connected transistor), a thyristor, or a logic circuit that is a combination thereof. In a case where a transistor is used as a switch, since the transistor is operated just as a switch, a polarity (conductive type) of the transistor is not limited particularly. However, in a case where a lower off current is desired, a transistor which has a polarity with a lower off current is desirably used. As the transistor with a low off current, a transistor provided with an LDD region, a transistor having a multi-gate structure, or the like can be used. In addition, it is desirable to use an n-channel transistor when a transistor to be operated as a switch operates in a state where a potential of a source terminal thereof is close to a low potential side power source (Vss, GND, 0 V, or the like), whereas it is desirable to use a p-channel transistor when a transistor operates in a state where a potential of a source terminal thereof is close to a high potential side power source (Vdd or the like). This is because the absolute value of a gate-source voltage can be increased, so that the transistor easily serves as a switch. Note that the switch may be of a CMOS type using both an n-channel transistor and p-channel transistor. In the case of a CMOS switch, current can flow when one of the p-channel and n-channel switches is electrically connected, so that the CMOS type switch can easily serve as a switch. For example, voltage can be outputted appropriately when voltage of signals inputted to the switch is high and also when voltage of signals inputted to the switch is low. In addition, since an amplitude value of voltage as signals for turning on/off a switch can be made low, power consumption can be lowered. Note that when a transistor is used as a switch, the transistor has an input terminal (one of a source terminal and a drain terminal), an output terminal (the other of the source terminal and the drain terminal) and a terminal controlling continuity (a gate terminal). On the other hand, when a diode is used as a switch, there may be a case where a terminal for controlling continuity is not provided. In such a case, a wire for controlling a terminal can be reduced.

In the present invention, a connection includes an electrical connection, a functional connection, and a direct connection. Accordingly, in the structure disclosed in the present invention, other connections than a predetermined connection may also be included. For example, at least one element which enables an electrical connection (e.g., a switch, a transistor, a capacitor, an inductor, a resistor, or a diode) may be interposed between a portion and another portion. In addition, one or more of circuits which enables a functional connection (e.g., a logic circuit (such as an inverter, a NAND circuit, or a NOR circuit), a signal converter circuit (such as a DA converter circuit, an AD converter circuit, or a gamma correction circuit), an electric potential level converter circuit (e.g., a power supply circuit such as a voltage step-up circuit or a voltage step-down circuit, or a level shift circuit for changing a potential level of an High signal or Low signal), a power source, a current source, a switching circuit, an amplifier circuit (such as an operational amplifier, a differential amplifier circuit, a source follower circuit, a buffer circuit, or a circuit which can increase a signal amplitude or a current amount), a signal generation circuit, a memory circuit, or a control circuit) may be arranged between a portion and another portion. Alternatively, direct connection may be conducted without interposing other elements or other circuits. Note that only the case that connection is conducted directly without interposing other elements or other circuits is described as being "directly connected". Meanwhile, description of "electrically connected" includes an electrical connection (i.e., a connection with another element interposed), a functional connection (i.e., a connection with another circuit interposed), and a direct connection (i.e., a connection without another element or another circuit interposed).

A display element, a display device, a light-emitting element, and a light-emitting device can employ various modes and include various elements. As an example, there is a display medium whose contrast changes by an electromagnetic function, such as an EL element (e.g., an organic EL element, an inorganic EL element, or an EL element containing an organic material or an inorganic material), an electron-emissive element, a liquid crystal element, electronic ink, a grating light valve (GLV), a plasma display (PDP), a digital micromirror device (DMD), a piezoceramic display, or a carbon nanotube. In addition, a display device using an EL element includes an EL display; a display device using an electron-emissive element includes a field emission display (FED) or a surface-conduction electron-emitter display (SED); a display device using a liquid crystal element includes a liquid crystal display, a transmissive liquid crystal display, a semi-transmissive liquid crystal display, or a reflective liquid crystal display; and a display device using electronic ink includes electronic paper.

In the invention, a transistor may have various modes; therefore, the type of applicable transistor is not specifically limited. It is thus possible to apply a thin film transistor (TFT) or the like using a non-single crystalline semiconductor film typified by amorphous silicon or polycrystalline silicon. Due to this, a transistor can be manufactured even with a low manufacturing temperature, with low cost, and over a large-sized and/or transparent substrate, and light can be emitted through the transistor. In addition, a MOS transistor, a junction type transistor, a bipolar transistor, or the like which are formed using a semiconductor substrate or an SOI substrate can be applied. Accordingly, a transistor with few variations, a transistor with high current supply capability, or a transistor with a small size can be manufactured, or a circuit with small power consumption can be manufactured. In addition, it is possible to apply a transistor using a compound semiconductor such as ZnO, a-InGaZnO, SiGe, or GaAs, a thin film transistor thereof, or the like. Due to this, manufacturing can be carried out with a temperature which is not so high, even at a room temperature, and a transistor can be directly formed over a low heat-resistant substrate such as a plastic substrate or a film substrate. In addition, a transistor or the like formed by an ink-jet method or a printing method can be applied. Due to this, manufacturing can be carried out at a room temperature, in a low-vacuum state, or over a large-sized substrate. In addition, since manufacturing can be conducted without a mask (reticle), a layout of a transistor can be easily changed. In addition, a transistor using an organic semiconductor or a carbon nanotube, or other transistors can be applied. Due to this, a transistor can be formed over a flexible substrate. Note that the non-single crystalline semiconductor film may contain hydrogen or halogen. Further, the type of substrate over which a transistor is provided is not specifically limited and various types of substrates may be used. Thus, for example, a transistor can be formed over a single crystalline substrate, an SOI substrate, a glass substrate, a quartz substrate, a plastic substrate, a paper substrate, a cellophane substrate, a stone substrate, a stainless-steel substrate, a substrate containing stainless-steel foil, or the like. Alternatively, a transistor may be formed over a substrate and then transferred onto another substrate to be disposed. By using these substrates, a transistor with favorable characteristics or a transistor with small power consumption, a transistor which hardly breaks, or a heat-resistant transistor can be formed.

Note that the structure of a transistor in the present invention is not limited to a certain type and various structures may be employed. For example, a multi-gate structure having two or more gate electrodes may be used. In the case of a multi-gate structure, since channel regions are connected in series, a structure in which a plurality of transistors is connected in series is obtained. By using the multi-gate structure, off current can be reduced as well as a withstand voltage can be increased to improve reliability of the transistor, and even when drain-source voltage fluctuates at the time when the transistor operates in a saturation region, flat characteristics can be provided without causing fluctuations of drain-source current. In addition, such a structure may also be employed in which gate electrodes are formed to over and below a channel. By using such a structure in which gate electrodes are formed over and below a channel, the area of the channel region can be enlarged to increase the current value flowing therein, and a depletion layer can be easily formed to increase the S value. In the case of forming gate electrodes over and below a channel, a structure in which a plurality of transistors is connected in parallel is obtained. In addition, any of the following structures may be employed in which a gate electrode is formed over a channel; a gate electrode is formed below a channel; a staggered structure; an inversed staggered structure; a structure where a channel region is divided into a plurality of regions; a structure where a channel region is divided into a plurality of regions and connected in parallel; or a structure where a channel region is divided into a plurality of regions and connected in series. In addition, a channel (or a part of it) may overlap a source electrode or a drain electrode. By forming a structure where a channel (or a part of it) overlaps a source electrode or a drain electrode, unstable operation can be prevented, which may be caused in the case where charges gather in a part of the channel. In addition, an LDD (Lightly Doped Drain) region may be provided. By providing an LDD region, off current can be reduced, withstand voltage can be increased to improve reliability of the transistor, and even when drain-source voltage fluctuates at the time when the transistor operates in the saturation region, flat characteristics can be provided without causing fluctuations of drain-source current.

Note that a transistor in the invention may be formed over a substrate of any type. Therefore, all circuits may be formed over a glass substrate, a plastic substrate, a single crystalline substrate, or an SOI substrate. By forming all circuits over the same substrates, the cost can be reduced since the number of components can be reduced and the reliability can be improved by reducing the number of connection among components in the circuit. Alternatively, such a structure may be employed in which some circuits are formed over a substrate, while some other circuits are formed over another substrate. That is, not the whole circuits are required to be formed over one substrate. For example, some circuits may be formed over a glass substrate by using transistors, while some other circuits may be formed over a single crystalline substrate, and then, the IC chip may be deposited onto the glass substrate by COG (Chip on Glass). Alternatively, the IC chip may be connected to the glass substrate by TAB (Tape Automated Bonding) or by using a printed board. In this manner, when some circuits are formed over one substrate, the cost can be reduced since the number of components can be reduced and the reliability can be improved by reducing the number of connection among components in the circuit. Further, a portion with high driving voltage or high driving frequency which consumes more power is not preferably formed over the same substrate, thereby increase in power consumption can be prevented.

In the present invention, one pixel corresponds to one element which can control brightness. Therefore, for example, one pixel expresses one color element by which brightness is expressed. Accordingly, in the case of a color display device formed of color elements of R (red), G (green), and B (blue), the smallest unit of an image is formed of three pixels of an R pixel, a G pixel, and a B pixel. Note that color elements are not limited to three kinds and may be more colors, and another color in addition to R, G, and B may be used. For example, R, G, B, and W (W is white) may be employed by adding white. Alternatively, one or more color of yellow, cyan, magenta, emerald green, or vermilion may be added to R, G, and B. In addition, a color similar to at least one color of R, G, or B may be added. For example, R, G, B**1**, and B**2** may be used. B**1** and B**2** both exhibit blue colors but have different frequencies. By using such color elements, it is possible to perform display that is much similar to the real and to reduce power consumption. Further, as another example, when controlling the brightness of one color element by using a plurality of regions, one of the plurality of regions corresponds to one pixel. Therefore, for example, in the case of performing an area gray scale display, a plurality of regions are provided for one color element to control the brightness, which express gray scale as a whole. One of the regions to control the brightness corresponds to one pixel. Therefore, in that case, one color element is formed by a plurality of pixels. Moreover, in that case, regions which contribute to display differ in sizes depending on the pixels. In the plurality of regions to control the brightness provided for one color element, that is, a plurality of pixels which form one color element, the viewing angle may be expanded by supplying each pixel with a slightly different signal. It is to be noted that the description of "one pixel (for three colors)" corresponds to one pixel including three pixels of R, G, and B. The description of "one pixel (for one color)" corresponds to pixels which are provided for one color element, and are collectively considered as one pixel.

Note that in the present invention, pixels may be provided (arranged) in matrix. Here, when it is described that pixels are provided (arranged) in matrix, there may be a case where the pixels are provided in a straight line or in a zigzag line in the longitudinal direction or in the lateral direction. Accordingly, in the case of performing full color display with three color elements (e.g., R, G, and B) for example, there may be a case where dots of three color elements are arranged in stripes or in delta pattern. Further, there may be a case where dots of the color elements are provided in the Bayer arrangement. Color elements are not limited to three kinds and may have more kinds. For example, there is R, G, B, and W (W is white), or R, G, B and at least one of yellow, cyan, or magenta. The area of a display region may differ among dots of the respective color elements. Accordingly, power consumption can be reduced, and a lifetime of a display element can be extended.

A transistor is an element having at least three terminals including a gate, a drain, and a source, and also has a channel formation region between the drain region and the source region, in which current flows through a drain region, a channel region, and a source region. Here, since the source and the drain are changed depending on a structure, an operation condition, or the like of a transistor, it is difficult to identify which is a source or a drain. Therefore, in the present invention, regions serving as a source and drain are not always referred to as a source and a drain. The region serving as a source and the one serving as a drain are sometimes referred to as a first terminal and a second terminal, respectively. Note that a transistor may be an element having at least three terminals including a base, an emitter, and a collector. In this case, an emitter and collector may be referred to as a first terminal and second terminal, respectively, as well.

A gate refers to a part or all of a gate electrode and a gate wire (also called a gate line, a gate signal line, or the like). The gate electrode refers to a conductive film which overlaps a semiconductor for forming a channel region or an LDD (Lightly Doped Drain) region with a gate insulating film sandwiched therebetween. The gate wire refers to a wire for connecting gate electrodes of different pixels, or a wire for connecting a gate electrode with another wire.

Note that there exists a portion serving as both a gate electrode and a gate wire. Such a region may be referred to as either a gate electrode or a gate wire. That is, there is a region where a gate electrode and a gate wire cannot be clearly distinguished from each other. For example, in the case where a channel region overlaps a gate wire which is extended, the overlapped region serves as both a gate wire and a gate electrode. Accordingly, such a region may be called either a gate electrode or a gate wire.

In addition, a region which is formed with the same material as the gate electrode and connected to the gate electrode may be referred to as a gate electrode. Similarly, a region which is formed of the same material as the gate wire and connected to the gate wire may be referred to as a gate wire. In the strict sense, such a region may not overlap the channel region or may not have a function of connecting to another gate electrode. However, there is a case where this region is formed with same material as the gate electrode or the gate wire and connected to the gate electrode or the gate wire in order to provide a sufficient manufacturing margin. Accordingly, such a region may also be referred to as a gate electrode or a gate wire.

In the case of a multi-gate transistor, for example, a gate electrode of a transistor is connected to a gate electrode of another transistor with the use of a conductive film which is formed with the same material as the gate electrodes. Since this region is a region for connecting a gate electrode to another gate electrode, it may be referred to as a gate wire, while it may also be called a gate electrode since the multi-gate transistor may be regarded as one transistor. That is, a region may be called a gate electrode or a gate wire as long as it is formed of the same material as a gate electrode or a gate wire and connected thereto. In addition, a part of a conductive film which connects a gate electrode to a gate wire, for example, may also be called a gate electrode or a gate wire.

Note that a gate terminal refers to a part of a gate electrode or a part of a region electrically connected to a gate electrode.

Note that a source refers to a part or all of a source region, a source electrode, and a source wire (also called a source line, a source signal line, or the like). A source region is a semiconductor region containing a large amount of p-type impurities (e.g., boron or gallium) or n-type impurities (e.g., phosphorus or arsenic). Accordingly, a source region does not include a region containing a slight amount of p-type impurities or n-type impurities, which is a so-called LDD region. The source electrode is a conductive layer which is formed of a different material from the source region and electrically connected to the source region. Note that there is a case where a source electrode and a source region are collectively referred to as a source electrode. A source wire is a wire for connecting source electrodes among different pixels, or a wire for connecting a source electrode with another wire.

However, there exists a portion serving as both a source electrode and a source wire. Such a region may be referred to as either a source electrode or a source wire. That is, there is a region where a source electrode and a source wire cannot be clearly distinguished from each other. For example, in the case where a source region overlaps a source wire which is extended, the overlapped region serves as both a source wire and a source electrode. Accordingly, such a region may be referred to as either a source electrode or a source wire.

In addition, a region which is formed with the same material as a source electrode and connected to the source electrode and a portion which connects a source electrode and another source electrode may each be referred to as a source electrode. A portion which overlaps a source region may be referred to as a source electrode as well. Similarly, a region which is formed of the same material as the source wire and connected to the source wire may be referred to as a source wire as well. In the strict sense, such a region may not have a function of connecting to another source electrode. However, there is a case where this region is formed with same material as the source electrode or the source wire and connected to the source electrode or the source wire in order to provide a sufficient manufacturing margin. Accordingly, such a region may also be referred to as a source electrode or a source wire.

In addition, a part of a conductive film which connects a source electrode to a source wire may be referred to as either a source electrode or a source wire, for example.

Note that a source terminal refers to a part of a source region, a source electrode, or a part of a region electrically connected to a source electrode.

Note also that a drain has a similar structure to the source.

Note that in the present invention, a semiconductor device refers to a device having a circuit including a semiconductor element (such as a transistor or a diode). In addition, it may also refer to a device in general that can operate by utilizing semiconductor characteristics. A display device refers to a device including a display element (such as a liquid crystal element or a light-emitting element). Note that it may also mean a main body of a display panel in which a plurality of pixels each including a display element such as a liquid crystal element or an EL element or a peripheral driver circuit for driving the pixels are formed over one substrate. In addition, a display device may include a peripheral driver circuit formed over a substrate with wire bonding, bump, or the like, that is a so-called chip on glass (COG) bonding. Moreover, it may include a device to which a flexible printed circuit (FPC) or a printed wiring board (PWB) is attached (such as an IC, a resistor, a capacitor, an inductor, or a transistor). Further, it may also include an optical sheet such as a polarizing plate or a retardation film. Furthermore, it may include a backlight unit (which may include a light guide plate, a prism sheet, a diffusion sheet, a reflection sheet, or a light source (such as an LED or a cold cathode tube)). In addition, a light-emitting device refers to a display device particularly including a self-emission type display element such as an EL element or an element used in FED. A liquid crystal display device refers to a display device including a liquid crystal element.

In the present invention, when it is described that an object is formed over another object, it does not necessarily mean that the object is in direct contact with the another object, and also the case is included where the above two objects are not in direct contact with each other, in other words, still another object may be sandwiched therebetween. Accordingly, when it is described that a layer B is formed over a layer A, it refers to either a case where the layer B is formed in direct contact with the layer A, or a case where another layer (e.g., a layer C or a layer D) is formed in direct contact with the layer A, and the layer B is formed in direct contact with the layer C or D. Similarly, when it is described that an object is formed above another object, it does not necessarily mean that the object is in direct contact with the another object, and still another object may be sandwiched therebetween. Accordingly, when it is described that a layer B is formed above a layer A, it refers to either a case where the layer B is formed in direct contact with the layer A, or a case where another layer (e.g., a layer C or a layer D) is formed in direct contact with the layer A, and then the layer B is formed in direct contact with the layer C or D. Similarly, when it is described that an object is formed below or under another object, it refers to either a case where the objects are in direct contact with each other or a case where the objects are not in direct contact with each other.

In this specification, a "source signal line" refers to a wire connected to an output of a source driver, in order to transmit video signals for controlling the operation of a pixel from the source driver.

In addition, in this specification, a "gate signal line" refers to a wire connected to an output of a gate driver, in order to transmit scan signals for controlling selection/non-selection of video signals writing to a pixel from the gate driver.

A burn-in correction period in which characteristics of a light-emitting element in each pixel are detected is provided in addition to a normal driving period in which an image is displayed, and video signals inputted to each pixel in the normal driving period are corrected according to the characteristics of the light-emitting elements obtained in the burn-in correction period, therefore, the light-emitting element can emit light which compensates changes in the characteristics of the light-emitting elements.

In addition, by providing a burn-in correction period, a user is not inconvenienced and a certain condition of obtaining the characteristics can be kept, which leads to obtaining of the characteristics of the light-emitting element with further accuracy.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** shows a display device of Embodiment Mode 1;
FIG. **2** shows a display device of Embodiment Mode 1;
FIG. **3** shows a display device of Embodiment Mode 2;
FIG. **4** shows a display device of Embodiment Mode 2;
FIG. **5** shows a display device of Embodiment Mode 3;
FIG. **6** shows a display device of Embodiment Mode 3;
FIG. **7** shows a display device of Embodiment Mode 3;
FIG. **8** shows a display device of Embodiment Mode 4;
FIG. **9** shows a display device of Embodiment Mode 5;
FIG. **10** shows a display device of Embodiment Mode 6;
FIG. **11** shows a display device of Embodiment Mode 7;
FIG. **12** shows a display device of Embodiment Mode 8;
FIG. **13** shows a display device of Embodiment Mode 9;
FIG. **14** shows a display device of Embodiment Mode 10;
FIG. **15** shows a display device of Embodiment Mode 11;
FIG. **16** shows a display device of Embodiment Mode 12;
FIG. **17** shows a display device of Embodiment Mode 13;
FIG. **18** shows a display device of Embodiment Mode 14;
FIG. **19** shows a display device of Embodiment Mode 15;
FIG. **20** shows a display device of Embodiment Mode 16;
FIG. **21** shows a display device of Embodiment Mode 17;
FIG. **22** shows a display device of Embodiment Mode 18;
FIG. **23** shows a display device of Embodiment Mode 19;
FIGS. **24**A and **24**B show display devices of Embodiment 1;
FIGS. **25**A to **25**C show display devices of Embodiment 6;
FIG. **26** is a display device of Embodiment 7;
FIGS. **27**A to **27**D show display devices of Embodiment 8;
FIGS. **28**A and **28**B show a display device of Embodiment 2;
FIGS. **29**A and **29**B show a display device of Embodiment 2;
FIGS. **30**A and **30**B show a display device of Embodiment 2;
FIGS. **31**A to **31**C show a display device of Embodiment 3;
FIGS. **32**A to **32**D show a display device of Embodiment 3;
FIGS. **33**A to **33**C show a display device of Embodiment 3;
FIGS. **34**A to **34**D show a display device of Embodiment 3;
FIGS. **35**A to **35**D show a display device of Embodiment 3;
FIGS. **36**A to **36**D show a display device of Embodiment 3;
FIGS. **37**A and **37**B show a display device of Embodiment 3;
FIGS. **38**A and **38**B show a display device of Embodiment 3;
FIG. **39** shows a display device of Embodiment 4;
FIGS. **40**A to **40**E show a display device of Embodiment 4;
FIGS. **41**A and **41**B show a display device of Embodiment 5;
FIGS. **42**A and **42**B show a display device of Embodiment 5;
FIGS. **43**A and **43**B show a display device of Embodiment 5;
FIG. **44** shows a display device of Embodiment Mode 26;
FIGS. **45**A to **45**C show a display device of Embodiment Mode 26;
FIG. **46** shows a display device of Embodiment Mode 26;
FIG. **47** shows a display device of Embodiment Mode 21;
FIG. **48** shows a display device of Embodiment Mode 24;
FIG. **49** shows a display device of Embodiment Mode 24;
FIG. **50** shows a display device of Embodiment Mode 22;
FIG. **51** shows a display device of Embodiment Mode 26;
FIG. **52** shows a display device of Embodiment Mode 26;
FIG. **53** shows a display device of Embodiment Mode 23;
FIG. **54** shows a display device of Embodiment Mode 23;
FIG. **55** shows a display device of Embodiment Mode 23;
FIG. **56** shows a display device of Embodiment Mode 23;
FIG. **57** shows a display device of Embodiment Mode 26;
FIG. **58** shows a display device of Embodiment Mode 26;
FIG. **59** shows a display device of Embodiment Mode 26;
FIG. **60** shows a display device of Embodiment Mode 26;
FIG. **61** shows a display device of Embodiment Mode 4;
FIG. **62** shows a display device of Embodiment Mode 5;
FIG. **63** shows a display device of Embodiment Mode 6;
FIG. **64** shows a display device of Embodiment Mode 7;

FIG. **65** shows a display device of Embodiment Mode 8;

FIG. **66** shows a display device of Embodiment Mode 9;

FIG. **67** shows a display device of Embodiment Mode 10;

FIG. **68** shows a display device of Embodiment Mode 11;

FIG. **69** shows a display device of Embodiment Mode 12;

FIG. **70** shows a display device of Embodiment Mode 13;

FIG. **71** shows a display device of Embodiment Mode 14;

FIG. **72** shows a display device of Embodiment Mode 15;

FIG. **73** shows a display device of Embodiment Mode 16;

FIG. **74** shows a display device of Embodiment Mode 17;

FIG. **75** shows a display device of Embodiment Mode 18;

FIG. **76** shows a display device of Embodiment Mode 19;

FIGS. **77**A and **77**B show application examples of a display device of the present invention;

FIG. **78** shows an application example of a display device of the present invention;

FIGS. **79**A and **79**B show application examples of a display device of the present invention;

FIG. **80** shows an application example of a display device of the present invention;

FIG. **81** shows an application example of a display device of the present invention; and

FIG. **82** shows an application example of a display device of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, embodiment mode of the present invention will be described in detail with the reference to the drawings. However, the present invention is not limited to the following description, and it is easily understood by those skilled art that various changes and modifications are possible, unless such changes and modifications depart from the spirit and the scope of the present invention. Therefore, the present invention is not construed as being limited to the description of the following embodiment mode.

Embodiment Mode 1

A description is made on a first structure of a display device of the present invention with reference to FIG. **1**.

In FIG. **1**, a source driver **101** is a circuit which outputs video signals to pixels **109** through source signal lines **103** indicated by reference symbols S**1**-R to Sn-B. Video signals may be outputted to all of the source signal lines **103** at the same time. Alternatively, the video signals may be outputted per column, or may be outputted to a plurality of the source signal lines at the same time.

A gate driver **102** scans gate signal lines **104** indicated by reference symbols G1 to Gm per row and judges whether video signals can be written to the pixels **109** or not. Video signals outputted from the source driver **101** are inputted to the pixels **109** in a selected row, whereas the video signals outputted from the source driver **101** are not inputted to the pixels **109** in a row which is not selected.

The pixel **109** includes at least a light-emitting element having a pair of electrodes, a driving TFT connected to one of the electrodes of the light-emitting element, and a switch which turns on by a selected gate signal line **104** and electrically connects the source signal line **103** and a gate of the driving TFT. When a gate signal line **104** is not selected, a switch thereof turns off. Another switch or another TFT may be provided between the source signal line **103** and a gate of the driving TFT, or a capacitor may be connected in series. In FIG. **1**, light-emitting elements included in the pixels **109** emit light of R (red), G (green), and B (blue). A light-emitting element which emits light of W (white) may be added thereto. Alternatively, the light-emitting elements included in the pixels **109** may emit light of any one of R (red), G (green), B (blue), or W (white). Further alternatively, colors may be expressed with a single color emission of white (W) and a color filter.

A power source R**110** supplies predetermined voltage from one terminal through a power supply line R**105** to the pixels **109** including light-emitting elements which emit R (red) light. A power source G**111** supplies predetermined voltage from one terminal through a power supply line G**106** to the pixels **109** including light-emitting elements which emit G (green) light. A power source B**112** supplies predetermined voltage from one terminal through a power supply line B**107** to the pixels **109** including light-emitting elements which emit B (blue) light.

The ones of the terminals of the power sources R**110**, G**111**, and B**112** are connected to the counter electrode **108** of the light-emitting elements included in all the pixels **109** to supply predetermined voltage.

A current value detection circuit **113** is connected in series to the counter electrode **108** and is controlled whether to detect the current value of the counter electrode **108** or not according to current value detection control signals outputted from a controller **115**. When the current of the counter electrode **108** is detected, the detected current value data is outputted to a correction circuit **114**.

The correction circuit **114** stores the current value data of the counter electrode **108** obtained by the current value detection circuit **113**. Then, according to the data of the counter electrode **108**, that is, characteristics of the light-emitting elements in the pixels **109**, correction of driver control signals and video signals which are generated from image signals **115***a* inputted from the controller **115** is carried out. The source driver **101** and the gate driver **102** are driven with the corrected driver control signals **114***a* and video signals **114***b*. Note that only video signals may be corrected. In addition, another memory circuit may be provided for storing the current value data of the counter electrode **108** obtained by the current value detection circuit **113**.

The controller **115** transmits image signals **115***a* to the correction circuit **114** and transmits current value detection control signals **115***b* to the current value detection circuit **113**, and controls them. In addition, the controller switches a burn-in correction period and a normal driving period which are described below, according to the image signals **115***a* and the current value detection control signals **115***b*.

A battery **117** (also referred to as a secondary battery) outputs a constant voltage to a power supply generating circuit **116** which serves as a power source. The battery **117** is provided with a charging unit **118** and the battery **117** can be charged by the charging unit **118** when potential thereof is lowered. The charging unit **118** can be used at an arbitrary timing.

The power supply generating circuit **116** can generate various voltages from the constant voltage supplied from the battery **117**. The generated voltages are supplied to a display device driver circuit **100** as a power source.

Although the battery **117** is shown as an example of a power source supplied to the power supply generating circuit **116**, a single-phase AC power source or three-phase AC power source may be employed. Alternatively, a power source which supplies a constant voltage generated from a single-phase AC power source or three-phase AC power source may be employed. When a single-phase AC power source or three-phase AC power source is employed, the charging unit **118** is not required. Therefore, voltage of a power source is not lowered, which is advantageous since the battery **117** is not drained in a burn-in correction period described below.

A description is made on a driving method for the first structure of a display device of the present invention with reference to FIG. **2**.

In a driving method for the first structure, a burn-in correction period and a normal driving period are provided separately, and in the burn-in correction period, a driving method for the first structure is carried out. The normal driving period is a time in which an image is displayed. The burn-in correction period is a time in which characteristics of light-emitting elements included in the pixels **109** are obtained.

The normal driving period is described. In the normal driving period, characteristics of light-emitting elements included in the pixels **109** are already stored in the correction circuit **114**. The correction circuit **114** corrects, according to characteristics data of the light-emitting elements included in the pixels **109**, driver control signals and video signals which are generated from image signals inputted from the controller **115**, and outputs the corrected driver control signals **114***a* and video signals **114***b* to the source driver **101** and the gate driver **102**. Then, the source driver **101** outputs the video signals to the source signal lines **103**. The gate driver **102** scans the gate signal lines **104** to let the pixels **109** emit light, and an image according to the image signals **115***a* is displayed. At this time, if characteristics of light-emitting element included in the pixels **109** are not stored in the correction circuit **114**, the driver control signals and video signals are not necessarily corrected. In this case, the current value detection circuit **113** is not operated according to current value detection control signals **115***b* outputted from the controller **115**. That is, current of the counter electrode **108** is not detected, and the current value data **113***a* is not outputted to the correction circuit **114**.

The burn-in correction period is described. In the burn-in correction period, the characteristics of light-emitting elements included in the pixels **109** are detected so as to store the data which is detected in the current value detection circuit **113** in the correction circuit **114**. Image signals **115***a* with which pixels emit light one by one are outputted to the correction circuit **114** from the controller **115**. At this time, the driver control signals and video signals are not corrected according to the characteristics data of light-emitting elements included in the pixels **109**, which is stored in the correction circuit **114**. In addition, the current value detection circuit **113** is controlled by the current value detection control signals **115***b* so that a current value of the counter electrode in each of the pixels is obtained and outputted to the correction circuit **114** to be stored in the correction circuit **114**. Thus, current of the counter electrode **108** including characteristics of a light-emitting element of each pixel **109** can be stored in the correction circuit **114**. The current value data to be stored in the correction circuit **114** is renewed in every burn-in correction period. That is, data is overwritten, which means that a memory for storing new data in every burn-in correction period is not required.

In the first structure of a display device of the present invention, the counter electrode **108** is connected to the current value detection circuit **113**. Since the counter electrode **108** is shared by every pixel **109**, the characteristics of light-emitting elements in every pixel **109** can be detected with one current value detection circuit **113**. Thus, the size of a circuit for detecting the characteristics of light-emitting elements included in the pixels **109** can be reduced, which leads to reduction in space and power consumption.

Embodiment Mode 2

A description is made on a second structure of a display device of the present invention with reference to FIG. **3**.

In this embodiment mode, the source driver **101**, the gate driver **102**, the source signal lines **103**, the gate signal lines **104**, the power supply line R**105**, the power supply line G**106**, the power supply line B**107**, the counter electrode **108**, the pixels **109**, the power source R**110**, the power source G**111**, the power source B**112**, the current value detection circuits **113**, the correction circuit **114**, the controller **115**, the power supply generating circuit **116**, the battery **117**, and the charging unit **118** have functions similar to those in Embodiment Mode 1.

The current value detection circuits **113** have a function similar to that of the current value detection circuit **113** described in Embodiment Mode 1, and which are connected in series to the power source R**110**, the power source G**111**, and a power source B**112**. It is controlled whether the current value of the power source R**110**, the power source G**111**, and the power source B**112** is detected or not in accordance with the current value detection control signals **115***b* outputted from the controller **115**. When current of the power source R**110**, the power source G**111**, and the power source B**112** is detected, detected current value data **113***a* is outputted to the correction circuit **114**.

A description is made on a driving method for the second structure of a display device of the present invention with reference to FIG. **4**.

In a driving method for the second structure, a burn-in correction period and a normal driving period are provided separately, and in the burn-in correction period, a driving method for the second structure is carried out. The normal driving period is a time in which an image is displayed. The burn-in correction period is a time in which characteristics of light-emitting elements included in the pixels **109** are obtained.

The normal driving period is described. In the normal driving period, characteristics of light-emitting elements included in the pixels **109** are already stored in the correction circuit **114**. The correction circuit **114** corrects, according to characteristics data of the light-emitting elements included in the pixels **109**, driver control signals and video signals which are generated from image signals **115***a* inputted from the controller **115** and outputs the corrected driver control signals **114***a* and video signals **114***b* to the source driver **101** and the gate driver **102**. Then, the source driver **101** outputs the video signals **114***b* to the source signal lines **103**. The gate driver **102** scans the gate signal lines **104** to let the pixels **109** emit light, and an image according to the image signals **115***a* is displayed.

The burn-in correction period is described. In the burn-in correction period, the characteristics of light-emitting elements included in the pixels **109** are detected so as to be stored in the correction circuit **114**. Image signals **115***a* with which the pixels **109** emit light of R, G, and B at the same time are outputted to the correction circuit **114** from the controller **115**. At this time, the driver control signals and video signals are not corrected according to the characteristics data of light-emitting elements included in the pixels **109**, which is stored in the correction circuit **114**. In addition, the current value detection circuit **113** is controlled by the current value detection control signals **115***b* so that current of the power supply line R**105**, power supply line G**106**, and power supply line

B**107** of each pixel is obtained at the same time and outputted to the correction circuit **114** to be stored in the correction circuit **114**. Thus, current of the power supply line R**105**, power supply line G**106**, and power supply line B**107** each including characteristics of the light-emitting element of the pixel **109** can be stored in the correction circuit **114**. The current value data **113***a* to be stored in the correction circuit **114** is renewed in every burn-in correction period. That is, data is overwritten, which means that a memory for storing new data in every burn-in correction period is not required.

In the second structure of a display device of the present invention, the power supply line R**105**, power supply line G**106**, and power supply line B**107** are connected to the current value detection circuits **113**. The connection of the power supply line R**105**, power supply line G**106**, and power supply line B**107** to the current value detection circuits **113** makes it possible to concurrently detect the characteristics of the light-emitting elements included in the pixels **109** which emit light of R, G, and B. Therefore, a burn-in correction period can be shortened significantly.

Embodiment Mode 3

A description is made on a third structure of a display device of the present invention with reference to FIG. **5**.

In this embodiment mode, the source driver **101**, the gate driver **102**, the source signal lines **103**, the gate signal lines **104**, the power supply line R**105**, the power supply line G**106**, the power supply line B**107**, the counter electrode **108**, the pixels **109**, the power source R**110**, the power source G**111**, the power source B**112**, a current value detection circuit **113**, the correction circuit **114**, the controller **115**, the power supply generating circuit **116**, the battery **117**, and the charging unit **118** have functions similar to those in Embodiment Modes 1 and 2.

The current value detection selector circuit **513** is connected in series to the power supply line R**105**, the power supply line G**106**, and the power supply line B**107**. The current value detection selector circuit **513** selects one of the power supply line R**105**, the power supply line G**106**, and the power supply line B**107** and detects current thereof.

A description is made on a driving method of the third structure of the display device of the present invention with reference to FIG. **6**.

In a driving method for the third structure, a burn-in correction period and a normal driving period are provided separately, and in the burn-in correction period, a driving method for the third structure is carried out. The normal driving period is a time in which an image is displayed. The burn-in correction period is a time in which characteristics of light-emitting elements included in the pixels **109** are obtained.

The normal driving period is described. In the normal driving period, characteristics of the light-emitting elements included in the pixels **109** are already stored in the correction circuit **114**. The correction circuit **114** corrects, according to characteristics data of the light-emitting elements included in the pixels **109**, driver control signals and video signals which are generated from image signals **115***a* inputted from the controller **115** and outputs the corrected driver control signals and video signals **114***a* to the source driver **101** and the gate driver **102**. Then, the source driver **101** outputs the video signals **101***a* to the source signal lines **103**. The gate driver **102** outputs scan signals **102***a* and scans the gate signal lines **104** to let the pixels **109** emit light, and an image according to the video signals is displayed.

The burn-in correction period is described. In the driving method for the third structure, there are two kinds of burn-in correction periods as described as a burn-in correction period **1** and a burn-in correction period **2**.

The burn-in correction period **1** is described. In the burn-in correction period **1**, the characteristics of light-emitting elements included in the pixels **109** are detected to be stored in the correction circuit **114**. Image signals **115***a* with which pixels emit light one by one are outputted to the correction circuit **114** from the controller **115**. At this time, the driver control signals and video signals are not corrected according to the characteristics data of light-emitting elements included in the pixels **109**, which is stored in the correction circuit **114**. In addition, the current value detection selector circuit **513** is controlled by the current value detection control signals **115***b* so that current in each pixel of the power supply line R**105**, power supply line G**106**, and power supply line B**107** is obtained sequentially and outputted to the correction circuit **114** to be stored in the correction circuit **114**. Thus, current of the power supply line R**105**, power supply line G**106**, and power supply line B**107** including characteristics of the light-emitting element of each pixel **109** can be stored in the correction circuit **114**. The current value data **513***a* to be stored in the correction circuit **114** is renewed in every burn-in correction period. That is, data is overwritten, which means that a memory for storing new data in every burn-in correction period is not required.

The burn-in correction period **2** is described. In the burn-in correction period **2**, the characteristics of light-emitting elements included in the pixels **109** are detected to be stored in the correction circuit **114**. Image signals **115***a* with which the pixels **109** emit light of R, G, and B at the same time are outputted to the correction circuit **114** from the controller **115**. At this time, the driver control signals and video signals are not corrected according to the characteristics data of light-emitting elements included in the pixels **109**, which is stored in the correction circuit **114**. In addition, the current value detection selector circuit **513** is controlled by the current value detection control signals **115***b* so that current of the power supply line R**105**, power supply line G**106**, and power supply line B**107** of each pixel is obtained sequentially and outputted to the correction circuit **114** to be stored in the correction circuit. Thus, current of the power supply line R**105**, power supply line G**106**, and power supply line B**107** including characteristics of the light-emitting element of each pixel **109** can be stored in the correction circuit **114**. The current value data **513***a* to be stored in the correction circuit **114** is renewed in every burn-in correction period. That is, data is overwritten, which means that a memory for storing new data in every burn-in correction period is not required.

A description is made on an example of a structure of the current value detection selector circuit **513** with reference to FIG. **7**.

In the burn-in correction period **1** and the burn-in correction period **2**, a select switch **701** selects whether each of the power supply line R**105**, the power supply line G**106**, and the power supply line B**107** is connected to a terminal a or a terminal b. Note that one of select switches **701** of the power supply line R**105**, power supply line G**106**, and power supply line B**107** is connected to the terminal a. All power supply lines which are not connected to the terminals a are connected to the terminals b.

The current value detection circuit **113** detects current flowing in a power supply line which is connected to the terminal b by the select switch **701**. In a normal driving period, all select switches **701** are connected to the terminals a.

In the third structure of a display device of the present invention, the power supply line R**105**, power supply line

G**106**, and power supply line B**107** are connected to the current value detection selector circuit **513**. The connection of the power supply line R**105**, power supply line G**106**, and power supply line B**107** to the current value detection selector circuit **513** makes it possible to detect each current of the power supply line R**105**, power supply line G**106**, and power supply line B**107** with one current value detection circuit **113**. Thus, the size of a circuit for detecting characteristics of light-emitting elements included in the pixels **109** can be reduced, which leads to reduction in space and power consumption.

Embodiment Mode 4

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **8**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, a "normal driving period" refers to a time in which an image can be displayed according to video signals, as described in Embodiment Modes 1 to 3.

A "burn-in correction period" refers to a time in which characteristics of light-emitting elements are obtained, as described in Embodiment Modes 1 to 3.

In a step of "passage of predetermined time", it is judged whether a predetermined time has passed or not after proceeding from the last burn-in correction period to a normal driving period.

In a step of "charging period", it is judged whether a battery mounted on an electronic appliance or the like of the present invention is charged or not by the user.

In a decision of "termination of all pixels", it is judged whether characteristics of light-emitting elements included in all pixels are obtained or not in a burn-in correction period.

In a decision of "start of operation", it is judged whether a user operates an electronic appliance of the present invention or not.

A description is made on the flow of a flow chart of FIG. **8**. If a predetermined time has not passed after the process proceeds from the last "burn-in correction period" to a "normal driving period" in the "passage of predetermined time", the process proceeds to the "normal driving period", whereas the process proceeds to a "charging period" if the predetermined time has passed. If a battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the battery is charged. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of all pixels". If characteristics of light-emitting elements included in all pixels are obtained in the "termination of all pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "charging period" if the characteristics of light-emitting elements included in all pixels are not obtained. If the battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the battery is charged. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "passage of predetermined time" to the conditions for proceeding from the normal driving period to the burn-in correction period, the number of proceedings to the burn-in correction period can be controlled. In the burn-in correction period, light-emitting elements included in pixels need to emit light as described in Embodiment Modes 1 to 3. Therefore, decrease in frequency of proceeding to the burn-in correction period can prevent deterioration of light-emitting elements included in pixels due to the burn-in correction period.

By adding the "charging period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period while charging the battery. In the burn-in correction period, light-emitting elements included in pixels emit light, so that characteristics of the light-emitting elements are stored as described in Embodiment Modes 1 to 3. Therefore, power consumption therein is large. Proceeding to the burn-in correction period while charging the battery can prevent reduction in power of the battery due to the burn-in correction period. Besides, when charging the battery, it is highly possible that the user has finished using the electronic appliance or the like and it is unlikely that the process returns to the normal driving period.

By adding the "termination of all pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, characteristics of the light-emitting elements included in all pixels can be detected under the same conditions. When the conditions under which characteristics of the light-emitting elements included in pixels are detected, that is, when the operating environments are the same, variation in characteristics due to difference in the operating environments can be suppressed.

By adding the "charging period" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period on finishing charging of the battery. Proceeding to the normal driving period from the burn-in correction period on finishing charging of the battery, drain of the battery can be suppressed. Besides, when charging the battery is finished, it is highly possible that the user is going to use the electronic appliance; therefore, the process needs to proceed to the normal driving period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "charging period" and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in all pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period. In addition, when the process proceeds to the next burn-in correction period, it is preferable that the predetermined time in the "passage of predetermined time" be shorter. The predetermined time is preferably zero second and the process preferably proceeds to the burn-in correction period via the next "charging period".

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **8** described in this embodiment mode, with reference to FIG. **61**.

In FIG. **61**, a driving method selection circuit **6103** decides and selects whether an image signal generation circuit **6100** and a current value detection control signal generation circuit **6101** conduct operation of the normal driving period or the burn-in correction period described in Embodiment Modes 1 to 3. The driving method selection circuit **6103** outputs signals for conducting operation of the burn-in correction period to the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** when signal for proceeding to the burn-in correction period is inputted from the circuit from which signal is inputted to the driving method selection circuit **6103**. In other cases, signals for conducting operation of the normal driving period are outputted therefrom. For example, the driving method selection circuit **6103** includes a discriminating circuit comprising NOR, AND.

The image signal generation circuit **6100** outputs the image signals and the correction circuit control signals **115***a*. When the operation of the normal driving period is selected by the driving method selection circuit **6103**, the image signals and the correction circuit control signals **115***a* are outputted with which the correction circuit **114** conducts operation of the normal driving period described in Embodiment Modes 1 to 3. When the operation of the burn-in correction period is selected by the driving method selection circuit **6103**, the image signals and the correction circuit control signals are outputted with which the correction circuit **114** conducts operation of the burn-in correction period described in Embodiment Modes 1 to 3.

The current value detection control signal generation circuit **6101** outputs the current value detection control signals **115***b*. When the operation of the normal driving period is selected by the driving method selection circuit **6103**, the current value detection control signals **115***b* are outputted with which the current value detection circuit **113** conducts operation of the normal driving period described in Embodiment Modes 1 to 3. When the operation of the burn-in correction period is selected by the driving method selection circuit **6103**, the current value detection control signals **115***b* are outputted with which the current value detection circuit **113** conducts operation of the burn-in correction period described in Embodiment Modes 1 to 3.

A timer circuit **6104** detects a time passed from the end of the burn-in correction period. When the burn-in correction period ends and the process proceeds to the normal driving period, reset signals **6100***a* are outputted from the video signal generation circuit **6100**, and signals for proceeding to the burn-in correction period are stopped. Note that as long as the reset signals **6100***a* are inputted to the timer circuit **6104** at the end of the burn-in correction period, the reset signals **6100***a* may be outputted from anywhere. When the time detected by the timer circuit **6104** is longer than the predetermined time, signals for proceeding to the burn-in correction period are outputted to the driving method selection circuit **6103**. The reset signals **6100***a* inputted to the timer circuit **6104** are not necessarily inputted if characteristics of all the pixels or set pixels are not detected. For example, the timer circuit **6104** includes a reset signal generation circuit, a counter, and a count value generation circuit, a memory, or a resistor in which count number corresponded to the predetermined time is stored.

A charging unit detection circuit **6105** judges whether the battery **117** is charged by the charging unit **118** or not. If the battery **117** is charged, signals for proceeding to the burn-in correction period are outputted to the driving method selection circuit **6103**. For example, the charging unit detection circuit **6105** includes a terminal, a high resistivity element, and a discriminating circuit in which 1 or 0 is judged.

A description is made on operation in this embodiment mode. When the predetermined time has passed from the input of the reset signals **6100***a* to the timer circuit **6104**, that is, the predetermined time has passed from the end of the last burn-in correction period, and the charging unit detection circuit **6105** detects charging of the battery **117**; the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of all pixels, the reset signals **6100***a* are inputted to the timer circuit **6104**. In this embodiment mode, between the "normal driving period" and the "burn-in correction period", the judgment of "passage of predetermined time", the judgment of "charging period", the judgment of "termination of all pixels", the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of predetermined time", the judgment of "charging period", the judgment of "termination of all pixels", and the judgment of "start of operation". That is, for example, between the normal driving period and the burn-in correction period, only the judgment of passage of predetermined time is conducted. In this case, the operation is conducted by using at least the timer circuit **6104** and the driving method selection circuit **6103**.

Embodiment Mode 5

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **9**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", the decision of "passage of predetermined time", the decision of "charging period", and the decision of "start of operation" are similar to those in Embodiment Mode 4. In a decision of "termination of set pixels", it is judged whether characteristics of light-emitting elements included in preset pixels are obtained or not. The preset pixels refer to pixels which are included in one portion, when all the pixels are divided into a plurality of portions. For example, when all the pixels are divided in two parts, the upper half portion and the lower half portion are formed.

A description is made on the flow of a flow chart of FIG. **9**. By adding the "passage of predetermined time" to the conditions for proceeding from the normal driving period to the burn-in correction period, the number of proceedings to the burn-in correction period can be controlled. In the burn-in correction period, light-emitting elements included in pixels need to emit light as described in Embodiment Modes 1 to 3. Therefore, decrease in frequency of proceeding to the burn-in correction period can prevent deterioration of light-emitting elements included in pixels due to the burn-in correction period.

By adding the "charging period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period while charging the battery. In the burn-in correction period, light-emitting elements included in pixels emit light, so that characteristics of the light-emitting elements are stored as described in Embodiment Modes 1 to 3. Therefore, power consumption therein is large. Proceeding to the burn-in correction period while charging the battery can prevent reduction in power of the battery due to the burn-in correction period. Besides, when charging the battery, it is highly possible that the user has finished using the electronic appliance or the like and it is unlikely that the process returns to the normal driving period.

By adding the "termination of set pixels" to the conditions with which the process proceeds from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period without interrupting the burn-in correction period. In addition it is possible that the process proceeds to the burn-in correction period selectively in a portion in which burn-in is supposed to be easily generated.

By adding the "charging period" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period on finishing charging of the battery. Proceeding to the normal driving period from the burn-in correction period on finishing charging of the battery, drain of the battery can be suppressed. Besides, when charging the battery is finished, it is highly possible that the user is going to use the electronic appliance; therefore, the process needs to proceed to the normal driving period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from burn-in correction period via the "charging period" and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in the preset pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period. In addition, when the process proceeds to the next burn-in correction period, it is preferable that the predetermined time in the "passage of predetermined time" be shorter. The predetermined time is preferably zero second and the process preferably proceeds to the burn-in correction period via the next "charging period".

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **9** described in this embodiment mode, with reference to FIG. **62**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, the timer circuit **6104**, and the charging unit detection circuit **6105** are similar to those in Embodiment Mode 4.

A detection pixel set circuit **6106** specifies pixels included in one portion, when all the pixels are divided into a plurality of portions.

A description is made on operation in this embodiment mode. When the predetermined time has passed from the input of the reset signals **6100***a* to the timer circuit **6104**, that is, the predetermined time has passed from the end of the last burn-in correction period, and the charging unit detection circuit **6105** detects charging of the battery **117**; the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of the pixels set by the detection pixel set circuit **6106**, the reset signals **6100***a* are inputted to the timer circuit **6104**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of predetermined time", the judgment of "charging period", the judgment of "termination of set pixels", the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of predetermined time", the judgment of "charging period", the judgment of "termination of set pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", only the judgment of "charging period" is conducted. In this case, the operation is conducted by using at least the charging unit detection circuit **6105** and the driving method selection circuit **6103**.

Embodiment Mode 6

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **10**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In FIG. **10**, the process of "normal driving period" refers to a time in which an image can be displayed according to video signals, as described in Embodiment Modes 1 to 3.

In this embodiment mode, the process of "burn-in correction period", the decision of "passage of predetermined time", the decision of "termination of all pixels" and the decision of "start of operation" are similar to those in Embodiment Mode 4. In a decision of "non-operating period", it is judged whether the user operates an electronic appliance or the like for a predetermined time or not.

A description is made on the flow of a flow chart of FIG. **10**. If a predetermined time has not passed after the process proceeds from the last "burn-in correction period" to a "normal driving period" in the "passage of predetermined time", the process proceeds to the "normal driving period", whereas the process proceeds to a "non-operating period" if the predetermined time has passed. If the user operates the electronic appliance or the like for the predetermined time in the "non-operating period", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user does not operate the electronic appliance or the like for the predetermined time. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of all pixels". If characteristics of light-emitting elements included in all pixels are obtained in the "termination of all pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the characteristics of light-emitting elements included in all pixels are not obtained. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "passage of predetermined time" to the conditions for proceeding from the normal driving period to the burn-in correction period, the number of proceedings to the burn-in correction period can be controlled. In the burn-in correction period, light-emitting elements included in pixels need to emit light as described in Embodiment Modes 1 to 3. Therefore, decrease in frequency of proceeding to the burn-in correction period can prevent deterioration of light-emitting elements included in pixels due to the burn-in correction period.

By adding the "non-operating period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period when the user does not operate the electronic appliance or the like. It can be judged that the electronic appliance or the like is not being used when the user does not operate the electronic appliance or the like for the predetermined time.

By adding the "termination of all pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, characteristics of the light-emitting elements included in all pixels can be detected under the same conditions. When the conditions under which characteristics of the light-emitting elements included in pixels are detected, that is, when the operating environments are the same, variation in characteristics due to difference in the operating environments can be suppressed.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in all pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period. In addition, when the process proceeds to the next burn-in correction period, it is preferable that the predetermined time in the "passage of predetermined time" be shorter. The predetermined time is preferably zero second and the process preferably proceeds to the burn-in correction period via the next "non-operating period".

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **10** described in this embodiment mode, with reference to FIG. **63**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, and the timer circuit **6104** are similar to those in Embodiment Mode 4.

A non-operating period detection circuit **6301** detects whether the user operates the electronic appliance or the like for the predetermined time or not. When the predetermined time has passed, the signals for proceeding to the burn-in correction period are outputted to the driving method selection circuit **6103**. For example, the non-operating period detection circuit **6301** includes of a reset signal generation circuit, a counter, and a count value generation circuit, a memory, or a resistor in which count number corresponded to the predetermined time is stored.

A description is made on operation in this embodiment mode. When the predetermined time has passed from the input of the reset signals **6100***a* to the timer circuit **6104**, that is, the predetermined time has passed from the end of the last burn-in correction period, and the user does not operate the electronic appliance or the like for a predetermined time; the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of all pixels, the reset signals **6100***a* are inputted to the timer circuit **6104**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of predetermined time", the judgment of "non-operating period", the judgment of "termination of all pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of predetermined time", the judgment of "non-operating period", the judgment of "termination of all pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", only the judgment of "non-operating period" is conducted. In this case, the operation is conducted by using at least the non-operating detection circuit **6301** and the driving method selection circuit **6103**.

Embodiment Mode 7

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **11**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the "normal driving period", the "burn-in correction period", the "passage of predetermined time", and the "start of operation" are similar to those in Embodiment Mode 4. The "non-operating period" is similar to that in Embodiment Mode 6. In the decision of "termination of set pixels", it is judged whether characteristics of light-emitting elements included in a preset pixel is obtained or not. The preset pixel refers to pixels which are included in one portion, when all the pixels are divided into a plurality of portions. For example, when all the pixels are divided in two parts, the upper half portion and the lower half portion are formed.

A description is made on the flow of a flow chart of FIG. **11**. If a predetermined time has not passed after the process proceeds from the last "burn-in correction period" to a "normal driving period" in the "passage of predetermined time", the process proceeds to the "normal driving period", whereas the process proceeds to a "non-operating period" if the predetermined time has passed. If the user operates the electronic appliance or the like for the predetermined time in the "non-operating period", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user does not operate the electronic appliance or the like for the predetermined time. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of set pixels". If characteristics of light-emitting elements included in the preset pixels are obtained in the "termination of set pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the characteristics of light-emitting elements included in the preset pixels are not obtained. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "passage of predetermined time" to the conditions for proceeding from the normal driving period to the burn-in correction period, the number of proceedings to the burn-in correction period can be controlled. In the burn-in correction period, light-emitting elements included in pixels need to emit light as described in Embodiment Modes 1 to 3. Therefore, decrease in frequency of proceeding to the burn-in correction period can prevent deterioration of light-emitting elements included in pixels due to the burn-in correction period.

By adding the "non-operating period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period when the user does not operate the electronic appliance or the like. It can be judged that the electronic appliance or the like is not being used when the user does not operate the electronic appliance or the like for the predetermined time.

By adding the "termination of set pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period without interrupting the burn-in correction period. In addition, it is possible that the process proceeds to the burn-in correction period selectively in a portion in which burn-in is supposed to be easily generated.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in the preset pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period. In addition, when the process proceeds to the next burn-in correction period, it is preferable that the predetermined time in the "passage of predetermined time" be shorter. The predetermined time is preferably zero second and the process preferably proceeds to the burn-in correction period via the next "non-operating period".

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **11** described in this embodiment mode with reference to FIG. **64**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, and the timer circuit **6104** are similar to those in Embodiment Mode 4. The detection pixel set circuit **6106** is similar to that in Embodiment Mode 5. The non-operating period detection circuit **6301** is similar to that in Embodiment Mode 6.

The non-operating period detection circuit **6301** detects whether the user operates the electronic appliance or the like for the predetermined time or not. When the predetermined time has passed, the signals for proceeding to the burn-in correction period are outputted to the driving method selection circuit **6103**.

A description is made on operation in this embodiment mode. When the predetermined time has passed from the input of the reset signals **6100*a*** to the timer circuit **6104**, that is, the predetermined time has passed from the end of the last burn-in correction period, and the user does not operate the electronic appliance or the like for a predetermined time; the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of the pixels set by the detection pixel set circuit **6106**, the reset signals **6100*a*** are inputted to the timer circuit **6104**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of predetermined time", the judgment of "non-operating period", the judgment of "termination of set pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of predetermined time", the judgment of "non-operating period", the judgment of termination of set pixels, and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", only the judgment of "termination of set pixels" is conducted. In this case, the operation is conducted by using at least the detection pixel set circuit **6106** and the driving method selection circuit **6103**.

Embodiment Mode 8

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **12**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the "normal driving period", the "burn-in correction period", the "passage of predetermined time", the "charging period", the "termination of all pixels", and the "start of operation" are similar to those in Embodiment Mode 4. In the "set luminance", it is judged whether the surrounding luminance is in the predetermined range or not.

A description is made on the flow of the flow chart of FIG. **12**. If a predetermined time has not passed after the process proceeds from the last "burn-in correction period" to the "normal driving period" in the "passage of predetermined time", the process proceeds to the "normal driving period", whereas the process proceeds to the "charging period" if the predetermined time has passed. If a battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the battery is charged. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the surrounding luminance is in the predetermined range. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of all pixels". If characteristics of light-emitting elements included in all pixels are obtained in the "termination of all pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "charging period" if the characteristics of light-emitting elements included in all pixels are not obtained. If the battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the battery is charged. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the surrounding luminance is in the predetermined range. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "passage of predetermined time" to the conditions for proceeding from the normal driving period to the burn-in correction period, the number of proceedings to the burn-in correction period can be controlled. In the burn-in correction period, light-emitting elements included in pixels need to emit light as described in Embodiment Modes 1 to 3. Therefore, decrease in frequency of proceeding to the burn-in correction period can prevent deterioration of light-emitting elements included in pixels due to the burn-in correction period.

By adding the "charging period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period while charging the battery. In the burn-in correction period, light-emitting elements included in pixels emit light, so that characteristics of the light-emitting elements are stored as described in Embodiment Modes 1 to 3. Therefore, power consumption therein is large. Proceeding to the burn-in correction period while charging the battery can prevent reduction in power of the battery due to the burn-in correction period. Besides, when charging the battery, it is highly possible that the user has finished using the electronic appliance or the like and it is unlikely that the process returns to the normal driving period.

By adding the "set luminance" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period without being effected by the surrounding luminance. In Embodiment Modes 1 to 3, one pixel or three pixels emit light at the same time and driving TFTs in the other pixels which do not emit light are in off state. Therefore, off-state current changes according to the surrounding luminance, which leads to variation in detected current value. By detecting the characteristics of the light-emitting elements included in the pixels when the surrounding luminances are the same, the effect of changes in surrounding luminance is eliminated. The surrounding luminance is preferably about 0 [cd/m^2]. In the case of a foldable mobile phone, such a state can be realized when the foldable mobile phone is folded and in the case of a digital camera, such a state can be realized when the digital camera is placed in its case.

By adding the "termination of all pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, characteristics of the light-emitting elements included in all pixels can be detected under the same conditions. When the conditions under which characteristics of the light-emitting elements included in pixels are detected, that is, when the operating environments are the same, variation in characteristics due to difference in the operating environments can be suppressed.

By adding the "charging period" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period on finishing charging of the battery. Proceeding to the normal driving period from the burn-in correction period on finishing charging of the battery, drain of the battery can be suppressed. Besides, when charging the battery is finished, it is highly possible that the user is going to use the electronic appliance; therefore, the process needs to proceed to the normal driving period.

By adding the "set luminance" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period immediately when the surrounding luminance changes during the burn-in correction period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "charging period", the "set luminance", and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in all pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period. In addition, when the process proceeds to the next burn-in correction period, it is preferable that the predetermined time in the "passage of predetermined time" be shorter. The predetermined time is preferably zero second and the process preferably proceeds to the burn-in correction period via the next "charging period" and the "set luminance".

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **12** described in this embodiment mode with reference to FIG. **65**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, the timer circuit **6104**, and the charging unit detection circuit **6105** are similar to those in Embodiment Mode 4.

A surrounding luminance detection circuit **6501** outputs signals to the driving method selection circuit **6103** for proceeding to the burn-in correction period when the surrounding luminance of the display device is close to the predetermined luminance. Note that the surrounding luminance is the luminance around the light-emitting portion of the display device driver circuit **100**. For example, even in the case where the set luminance is 0 [cd/m^2] and the luminance around the electronic appliance is different from the set luminance, if the display device driver circuit **100** is shielded from light and the luminance thereof is approximately 0 [cd/m^2], the signals for proceeding to the burn-in correction period is outputted to the driving method selection circuit **6103**. For example, the surrounding luminance detection circuit **6501** includes a photosensor, a current-voltage converter circuit, an analog digital converter, a memory **1** in which a maximum luminance data is stored, a memory **2** in which a minimum luminance data is stored, a comparator **1**, a comparator **2**, and a discriminating circuit such as NOR and AND.

A description is made on operation in this embodiment mode. When the predetermined time has passed from the input of the reset signals **6100***a* to the timer circuit **6104**, that is, the predetermined time has passed from the end of the last burn-in correction period, and the charging unit detection circuit **6105** detects charging of the battery **117** and the surrounding luminance detection circuit **6501** decides that the surrounding luminance of the display device is close to the predetermined luminance; the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of all pixels, the reset signals **6100***a* are inputted to the timer circuit **6104**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of predetermined time", the judgment of "charging period", the judgment of "set luminance", the judgment of "termination of all pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "charging period", the judgment of "set luminance", the judgment of "termination of all pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", only the judgment of "termination of set luminance" is conducted. In this case, the operation is conducted by using at least the surrounding luminance detection circuit **6501** and the driving method selection circuit **6103**.

Embodiment Mode 9

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **13**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", the decision of "passage of predetermined time", the decision of "charging period", and the decision of "start of operation" are similar to those in Embodiment Mode 4. The decision of "termination of set pixels" is similar to that in Embodiment Mode 7. The decision of "set luminance" is similar to that in Embodiment Mode 8.

A description is made on the flow of the flow chart of FIG. **13**. If a predetermined time has not passed after the process proceeds from the last "burn-in correction period" to the "normal driving period" in the "passage of predetermined time", the process proceeds to the "normal driving period", whereas the process proceeds to the "charging period" if the predetermined time has passed. If a battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the battery is charged. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the surrounding luminance is in the predetermined range. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of set pixels". If characteristics of light-emitting elements included in preset pixels are obtained in the "termination of set pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "charging period" if the characteristics of light-emitting elements included in the preset pixels are not obtained. If the battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the battery is charged. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the surrounding luminance is in the predetermined range. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "passage of predetermined time" to the conditions for proceeding from the normal driving period to the burn-in correction period, the number of proceedings to the burn-in correction period can be controlled. In the burn-in correction period, light-emitting elements included in pixels need to emit light as described in Embodiment Modes 1 to 3. Therefore, decrease in frequency of proceeding to the burn-in correction period can prevent deterioration of light-emitting elements included in pixels due to the burn-in correction period.

By adding the "charging period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period while charging the battery. In the burn-in correction period, light-emitting elements included in pixels emit light, so that characteristics of the light-emitting elements are stored as described in Embodiment Modes 1 to 3. Therefore, power consumption therein is large. Proceeding to the burn-in correction period while charging the battery can prevent reduction in power of the battery due to the burn-in correction period. Besides, when charging the battery, it is highly possible that the user has finished using the electronic appliance or the like and it is unlikely that the process returns to the normal driving period.

By adding the "set luminance" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period without being effected by the surrounding luminance. In Embodiment Modes 1 to 3, one pixel or three pixels emit light at the same time and driving TFTs in the other pixels which do not emit light are in off state. Therefore, off-state current changes according to the surrounding luminance, which leads to variation in detected current value. By detecting the characteristics of the light-emitting elements included in the pixels when the surrounding luminances are the same, the effect of changes in surrounding luminance is eliminated. The surrounding luminance is preferably about 0 [cd/m^2]. In the case of a foldable mobile phone, such a state can be realized when the foldable mobile phone is folded and in the case of a digital camera, such a state can be realized when the digital camera is placed in its case.

By adding the "termination of set pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period without interrupting the burn-in correction period. In addition, it is possible that the process proceeds to the burn-in correction period selectively in a portion in which burn-in is supposed to be easily generated.

By adding the "charging period" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period on finishing charging of the battery. Proceeding to the normal driving period from the burn-in correction period on finishing charging of the battery, drain of the battery can be suppressed. Besides, when charging the battery is finished, it is highly possible that the user is going to use the electronic appliance; therefore, the process needs to proceed to the normal driving period.

By adding the "set luminance" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period immediately when the surrounding luminance changes during the burn-in correction period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "charging period", the "set luminance", and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in preset pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period. In addition, when the process proceeds to the next burn-in correction period, it is preferable that the predetermined time in the "passage of predetermined time" be shorter. The predetermined time is preferably zero second and the process preferably proceeds to the burn-in correction period via the next "charging period" and the next "set luminance".

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **13** described in this embodiment mode, with reference to FIG. **66**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, the timer circuit **6104**, and the charging unit detection circuit **6105** are similar to those in Embodiment Mode 4. The detection pixel set circuit **6106** is similar to that in Embodiment Mode 5. The surrounding luminance detection circuit **6501** is similar to that in Embodiment Mode 8.

A description is made on operation in this embodiment mode. When the predetermined time has passed from the input of the reset signals **6100***a* to the timer circuit **6104**, that is, the predetermined time has passed from the end of the last burn-in correction period, and the charging unit detection circuit **6105** detects charging of the battery **117** and the surrounding luminance detection circuit **6501** decides that the surrounding luminance of the display device is close to the predetermined luminance; the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of the pixels set by the detection pixel set circuit **6106**, the reset signals **6100***a* are inputted to the timer circuit **6104**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of predetermined time", the judgment of "charging period", the judgment of "set luminance", the judgment of "termination of set pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "charging period", the judgment of "set luminance", the judgment of "termination of set pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", only the judgment of "termination of set pixels" is conducted. In this case, the operation is conducted by using at least the detection pixel set circuit **6106** and the driving method selection circuit **6103**.

Embodiment Mode 10

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **14**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", the decision of "passage of predetermined time", the decision of "termination of all pixels", and the decision of "start of operation" are similar to those in Embodiment Mode 4. The decision of "non-operating period" is similar to that in Embodiment Mode 6. The decision of "set luminance" is similar to that in Embodiment Mode 8.

A description is made on the flow of the flow chart of FIG. **14**. If a predetermined time has not passed after the process proceeds from the last "burn-in correction period" to a "normal driving period" in the "passage of predetermined time", the process proceeds to the "normal driving period", whereas the process proceeds to a "non-operating period" if the predetermined time has passed. If the user operates the electronic appliance or the like for the predetermined time in the "non-operating period", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the user does not operate the electronic appliance or the like for the predetermined time. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the surrounding luminance is in the predetermined range. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of all pixels". If characteristics of light-emitting elements included in all pixels are obtained in the "termination of all pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the characteristics of light-emitting elements included in all pixels are not obtained. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the surrounding luminance is in the predetermined range. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "passage of predetermined time" to the conditions for proceeding from the normal driving period to the burn-in correction period, the number of proceedings to the burn-in correction period can be controlled. In the burn-in correction period, light-emitting elements included in pixels need to emit light as described in Embodiment Modes 1 to 3. Therefore, decrease in frequency of proceeding to the burn-in correction period can prevent deterioration of light-emitting elements included in pixels due to the burn-in correction period.

By adding the "non-operating period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period when the user does not operate the electronic appliance or the like. It can be judged that the electronic appliance or the like is not being used when the user does not operate the electronic appliance or the like for the predetermined time.

By adding the "set luminance" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period without being effected by the surrounding luminance. In Embodiment Modes 1 to 3, one pixel or three pixels emit light at the same time and driving TFTs in the other pixels which do not emit light are in off state. Therefore, off-state current changes according to the surrounding luminance, which leads to variation in detected current value. By detecting the characteristics of the light-emitting elements included in the pixels when the surrounding luminances are the same, the effect of changes in surrounding luminance is eliminated. The surrounding luminance is preferably about 0 [cd/m^2]. In the case of a foldable mobile phone, such a state can be realized when the foldable mobile phone is folded and in the case of a digital camera, such a state can be realized when the digital camera is placed in its case.

By adding the "termination of all pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, characteristics of the light-emitting elements included in all pixels can be detected under the same conditions. When the conditions under which characteristics of the light-emitting elements included in pixels are detected, that is, when the operating environments are the same, variation in characteristics due to difference in the operating environments can be suppressed.

By adding the "charging period" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period on finishing charging of the battery. Proceeding to the normal driving period from the burn-in correction period on finishing charging of the battery, drain of the battery can be suppressed. Besides, when charging the battery is finished, it is highly possible that the user is going to use the electronic appliance; therefore, the process needs to proceed to the normal driving period.

By adding the "set luminance" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period immediately when the surrounding luminance changes during the burn-in correction period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "set luminance" and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in all pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period. In addition, when the process proceeds to the next burn-in correction period, it is preferable that the predetermined time in the "passage of predetermined time" be shorter. The predetermined time is preferably zero second and the process preferably proceeds to the burn-in correction period via the next "non-operating period" and "set luminance".

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **14** described in this embodiment mode, with reference to FIG. **67**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, and the timer circuit **6104** are similar to those in Embodiment Mode 4. The non-operating period detection circuit **6301** is similar to that in Embodiment Mode 6. The surrounding luminance detection circuit **6501** is similar to that in Embodiment Mode 8.

A description is made on operation in this embodiment mode. When the predetermined time has passed from the input of the reset signals **6100*a*** to the timer circuit **6104**, that is, the predetermined time has passed from the end of the last burn-in correction period, and the user does not operate the electronic appliance or the like for a predetermined time and the surrounding luminance detection circuit **6501** decides that the surrounding luminance of the display device is close to the predetermined luminance; the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of all pixels, the reset signals **6100***a* are inputted to the timer circuit **6104**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of predetermined time", the judgment of "non-operating period", the judgment of "set luminance", the judgment of "termination of all pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of predetermined time", the judgment of "non-operating period", the judgment of "set luminance", the judgment of "termination of all pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of predetermined time", and the judgment of "set luminance" are conducted. In this case, the operation is conducted by using at least the timer circuit **6104**, the surrounding luminance detection circuit **6501**, and the driving method selection circuit **6103**.

Embodiment Mode 11

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **15**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", the decision of "passage of predetermined time", and the decision of "start of operation" are similar to those in Embodiment Mode 4. The decision of "non-operating period" is similar to that in Embodiment Mode 6. The decision of "termination of set pixels" is similar to that in Embodiment Mode 7. The decision of "set luminance" is similar to that in Embodiment Mode 8.

A description is made on the flow of the flow chart of FIG. **15**. If a predetermined time has not passed after the process proceeds from the last "burn-in correction period" to a "normal driving period" in the "passage of predetermined time", the process proceeds to the "normal driving period", whereas the process proceeds to a "non-operating period" if the predetermined time has passed. If the user operates the electronic appliance or the like for the predetermined time in the "non-operating period", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the user does not operate the electronic appliance or the like for the predetermined time. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the surrounding luminance is in the predetermined range. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of set pixels". If characteristics of light-emitting elements included in the preset pixels are obtained in "termination of set pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the characteristics of light-emitting elements included in the preset pixels are not obtained. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the surrounding luminance is in the predetermined range. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "passage of predetermined time" to the conditions for proceeding from the normal driving period to the burn-in correction period, the number of proceedings to the burn-in correction period can be controlled. In the burn-in correction period, light-emitting elements included in pixels need to emit light as described in Embodiment Modes 1 to 3. Therefore, decrease in frequency of proceeding to the burn-in correction period can prevent deterioration of light-emitting elements included in pixels due to the burn-in correction period.

By adding the "non-operating period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period when the user does not operate the electronic appliance or the like. It can be judged that the electronic appliance or the like is not being used when the user does not operate the electronic appliance or the like for the predetermined time.

By adding the "set luminance" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period without being effected by the surrounding luminance. In Embodiment Modes 1 to 3, one pixel or three pixels emit light at the same time and driving TFTs in the other pixels which do not emit light are in off state. Therefore, off-state current changes according to the surrounding luminance, which leads to variation in detected current value. By detecting the characteristics of the light-emitting elements included in the pixels when the surrounding luminances are the same, the effect of changes in surrounding luminance is eliminated. The surrounding luminance is preferably about 0 [cd/m^2]. In the case of a foldable mobile phone, such a state can be realized when the foldable mobile phone is folded and in the case of a digital camera, such a state can be realized when the digital camera is placed in its case.

By adding the "termination of set pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period without interrupting the burn-in correction period. In addition, it is possible that the process proceeds to the burn-in correction period selectively in a portion in which burn-in is supposed to be easily generated.

By adding the "charging period" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period on finishing charging of the battery. Proceeding to the normal driving period from the burn-in correction period on finishing charging of the battery, drain of the battery can be suppressed. Besides, when charging the battery is finished, it is highly possible that the user is going to use the electronic appliance; therefore, the process needs to proceed to the normal driving period.

By adding the "set luminance" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period immediately when the surrounding luminance changes during the burn-in correction period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "set luminance" and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in preset pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period. In addition, when the process proceeds to the next burn-in correction period, it is preferable that the predetermined time in the "passage of predetermined time" be shorter. The predetermined time is preferably zero second and the process preferably proceeds to the burn-in correction period via the next "non-operating period" and "set luminance".

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **15** described in this embodiment mode, with reference to FIG. **68**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, and the timer circuit **6104** are similar to those in Embodiment Mode 4. The detection pixel set circuit **6106** is similar to that in Embodiment Mode 5. The non-operating period detection circuit **6301** is similar to that in Embodiment Mode 6. The surrounding luminance detection circuit **6501** is similar to that in Embodiment Mode 8.

A description is made on operation in this embodiment mode. When the predetermined time has passed from the input of the reset signals **6100***a* to the timer circuit **6104**, that is, the predetermined time has passed from the end of the last burn-in correction period, and the user does not operate the electronic appliance or the like for a predetermined time and the surrounding luminance detection circuit **6501** decides that the surrounding luminance of the display device is close to the predetermined luminance; the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of the pixels set by the detection pixel set circuit **6106**, the reset signals **6100***a* are inputted to the timer circuit **6104**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of predetermined time", the judgment of "non-operating period", the judgment of "set luminance", the judgment of "termination of set pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of predetermined time", the judgment of "non-operating period", the judgment of "set luminance", the judgment of "termination of set pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", the judgment of "non-operating period" and the judgment of "set luminance" are conducted. In this case, the operation is conducted by using at least the non-operating period detection circuit **6301**, the surrounding luminance detection circuit **6501**, and the driving method selection circuit **6103**.

Embodiment Mode 12

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **16**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", the decision of "termination of all pixels", and the decision of "start of operation" are similar to those in Embodiment Mode 4. In a decision of "user decision", the user of the electronic appliance or the like of the present invention decides whether the process proceeds to the burn-in correction period or not.

A description is made on the flow of the flow chart of FIG. **16**. In the "user decision", if the user does not determine that the process proceeds to the "burn-in correction period", the process proceeds to the "normal driving period, whereas the process proceeds to the "burn-in correction period" if the user determines that the process proceeds to the "burn-in correction period". When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of all pixels". If characteristics of light-emitting elements included in all pixels are obtained in the "termination of all pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the characteristics of light-emitting elements included in all pixels are not obtained. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "user decision" to the conditions for proceeding from the normal driving period to the burn-in correction period, the user can decide whether the process proceeds to the burn-in correction period or not. Therefore, the decision of proceeding to the burn-in correction period is made to suit each user since frequency of using the electronic appliance or the like and the display screen or the like thereof are different depending on users.

By adding the "termination of all pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, characteristics of the light-emitting elements included in all pixels can be detected under the same conditions. When the conditions under which characteristics of the light-emitting elements included in pixels are detected, that is, when the operating environments are the same, variation in characteristics due to difference in the operating environments can be suppressed.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in all pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period.

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **16** described in this embodiment mode, with reference to FIG. **69**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, and the driving method selection circuit **6103** are similar to those in Embodiment Mode 4.

A start circuit **6901** operates when the user determines that the process proceeds to the burn-in correction period and conducts certain operation. When the burn-in correction period ends and the process proceeds to the normal driving period, reset signals **6100***a* are outputted from the video signal generation circuit **6100**, and signals for proceeding to the burn-in correction period are stopped. Note that as long as the reset signals are inputted to the start circuit **6901** at the end of the burn-in correction period, the reset signals may be outputted from anywhere. When the user determines that the process proceeds to the burn-in correction period in the start circuit **6901**, signals for proceeding to the burn-in correction period are outputted to the driving method selection circuit **6103**. When the user determines that the process proceeds to the normal driving period, signals for proceeding to the burn-in correction period are stopped. The reset signals inputted to the start circuit **6901** are not necessarily inputted if characteristics of all the pixels or set pixels are not detected. For example, the start circuit **6901** includes a 1-bit counter.

A description is made on operation in this embodiment mode. When the user determines that the process proceeds to the burn-in correction period, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of all pixels, the reset signals are inputted to the start circuit **6901**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of user decision", the judgment of "termination of all pixels", and "the judgment of start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of user decision", the judgment of "termination of all pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", the judgment of "user decision" is conducted. In this case, the operation is conducted by using at least the start circuit **6901** and the driving method selection circuit **6103**.

Embodiment Mode 13

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **17**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", and the decision of "start of operation" are similar to those in Embodiment Mode 4. The decision of "termination of set pixels" is similar to that in Embodiment Mode 7. The decision of "user decision" is similar to that in Embodiment Mode 12.

A description is made on the flow of the flow chart of FIG. **17**. In the "user decision", if the user does not determine that the process proceeds to the "burn-in correction period", the process proceeds to the "normal driving period, whereas the process proceeds to the "burn-in correction period" if the user determines that the process proceeds to the "burn-in correction period". When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of set pixels". If characteristics of light-emitting elements included in the preset pixels are obtained in "termination of set pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the characteristics of the light-emitting elements included in the preset pixels are not obtained. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "user decision" to the conditions for proceeding from the normal driving period to the burn-in correction period, the user can decide whether the process proceeds to the burn-in correction period or not. Therefore, the decision of proceeding to the burn-in correction period is made to suit each user since frequency of using the electronic appliance or the like and the display screen or the like thereof are different depending on users.

By adding the "termination of set pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period without interrupting the burn-in correction period. In addition, it is possible that the process proceeds to the burn-in correction period selectively in a portion in which burn-in is supposed to be easily generated.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in the preset pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected via the next burn-in correction period.

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **17** described in this embodiment mode, with reference to FIG. **70**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, and the driving method selection circuit **6103** are similar to those in Embodiment Mode 4. The detection pixel set circuit **6106** is similar to that in Embodiment Mode 5. The start circuit **6901** is similar to that in Embodiment Mode 12.

A description is made on operation in this embodiment mode. When the user determines that the process proceeds to the burn-in correction period, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of the pixels set by the detection pixel set circuit **6106**, the reset signals are inputted to the start circuit **6901**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of user decision", the judgment of "termination of set pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of user decision", the judgment of "termination of set pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", the judgment of user decision is conducted. In this case, the operation is conducted by using at least the start circuit **6901** and the driving method selection circuit **6103**.

Embodiment Mode 14

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **18**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", the decision of "charging period", the decision of "termination of all pixels" and the decision of "start of operation" are similar to those in Embodiment Mode 4. The decision of "user decision" is similar to that in Embodiment Mode 12.

A description is made on the flow of the flow chart of FIG. **18**. In the "user decision", if the user does not determine that the process proceeds to the "burn-in correction period", the process proceeds to the "normal driving period, whereas the process proceeds to the "charging period" if the user determines that the process proceeds to the "burn-in correction period" "charging period". If a battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the battery is charged. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of all pixels". If characteristics of light-emitting elements included in all pixels are obtained in the "termination of all pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "charging period" if the characteristics of light-emitting elements included in all pixels are not obtained. If the battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the battery is charged. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "user decision" to the conditions for proceeding from the normal driving period to the burn-in correction period, the user can decide whether the process proceeds to the burn-in correction period or not. Therefore, the decision of proceeding to the burn-in correction period is made to suit each user since frequency of using the electronic appliance or the like and the display screen or the like thereof are different depending on users.

By adding the "charging period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period while charging the battery. In the burn-in correction period, light-emitting elements included in pixels emit light, so that characteristics of the light-emitting elements are stored as described in Embodiment Modes 1 to 3. Therefore, power consumption therein is large. Proceeding to the burn-in correction period while charging the battery can prevent reduction in power of the battery due to the burn-in correction period. Besides, when charging the battery, it is highly possible that the user has finished using the electronic appliance or the like and it is unlikely that the process returns to the normal driving period.

By adding the "termination of all pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, characteristics of the light-emitting elements included in all pixels can be detected under the same conditions. When the conditions under which characteristics of the light-emitting elements included in pixels are detected, that is, when the operating environments are the same, variation in characteristics due to difference in the operating environments can be suppressed.

By adding the "charging period" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period on finishing charging of the battery. Proceeding to the normal driving period from the burn-in correction period on finishing charging of the battery, drain of the battery can be suppressed. Besides, when charging the battery is finished, it is highly possible that the user is going to use the electronic appliance; therefore, the process needs to proceed to the normal driving period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "charging period" and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in the all pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period.

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **18** described in this embodiment mode, with reference to FIG. **71**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, and the charging unit detection circuit **6105** are similar to those in Embodiment Mode 4. The start circuit **6901** is similar to that in Embodiment Mode 12.

A description is made on operation in this embodiment mode. When the user determines that the process proceeds to the burn-in correction period and the charging unit detection circuit **6105** detects charging of the battery **117**, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of all pixels, the reset signals **6100*a*** are inputted to the start circuit **6901**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of user decision", the judgment of "charging period", the judgment of "termination of all pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of user decision", the judgment of "charging period", the judgment of "termination of all pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", the judgment of "user decision" is conducted. In this case, the operation is conducted by using at least the start circuit **6901**, the charging unit detection circuit **6105** and the driving method selection circuit **6103**.

Embodiment Mode 15

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **19**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", the decision of "charging period", and the decision of "start of operation" are similar to those in Embodiment Mode 4. The decision of "termination of set pixels" is similar to that in Embodiment Mode 7. The decision of "user decision" is similar to that in Embodiment Mode 12.

A description is made on the flow of the flow chart of FIG. **19**. In the "user decision", if the user does not determine that the process proceeds to the "burn-in correction period", the process proceeds to the "normal driving period", whereas the process proceeds to the "charging period" if the user determines that the process proceeds to the "burn-in correction period". If a battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the battery is charged. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of set pixels". If characteristics of light-emitting elements included in the preset pixels are obtained in the "termination of set pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "charging period" if the characteristics of light-emitting elements included in the preset pixels are not obtained. If the battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the battery is charged. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "user decision" to the conditions for proceeding from the normal driving period to the burn-in correction period, the user can decide whether the process proceeds to the burn-in correction period or not. Therefore, the decision of proceeding to the burn-in correction period is made to suit each user since frequency of using the electronic appliance or the like and the display screen or the like thereof are different depending on users.

By adding the "charging period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period while charging the battery. In the burn-in correction period, light-emitting elements included in pixels emit light, so that characteristics of the light-emitting elements are stored as described in Embodiment Modes 1 to 3. Therefore, power consumption therein is large. Proceeding to the burn-in correction period while charging the battery can prevent reduction in power of the battery due to the burn-in correction period. Besides, when charging the battery, it is highly possible that the user has finished using the electronic appliance or the like and it is unlikely that the process returns to the normal driving period.

By adding the "termination of set pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period without interrupting the burn-in correction period. In addition, it is possible that the process proceeds to the burn-in correction period selectively in a portion in which burn-in is supposed to be easily generated.

By adding the "charging period" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period on finishing charging of the battery. Proceeding to the normal driving period from the burn-in correction period on finishing charging of the battery, drain of the battery can be suppressed. Besides, when charging the battery is finished, it is highly possible that the user is going to use the electronic appliance; therefore, the process needs to proceed to the normal driving period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "charging period" and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in the preset pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period.

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **19** described in this embodiment mode, with reference to FIG. **72**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, and the charging unit detection circuit **6105** are similar to those in Embodiment Mode 4. The detection pixel set circuit **6106** is similar to that in Embodiment Mode 5. The start circuit **6901** is similar to that in Embodiment Mode 12.

A description is made on operation in this embodiment mode. When the user determines that the process proceeds to the burn-in correction period and the charging unit detection circuit **6105** detects charging of the battery **117**, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of the pixels set by the detection pixel set circuit **6106**, the reset signals **6100***a* are inputted to the start circuit **6901**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of user decision", the judgment of "charging period", the judgment of "termination of set pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of user decision", the judgment of "charging period", the judgment of "termination of set pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", the judgment of "user decision" and "charging period" are conducted. In this case, the operation is conducted by using at least the start circuit **6901**, the charging unit detection circuit **6105** and the driving method selection circuit **6103**.

Embodiment Mode 16

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **20**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", the decision of "termination of all pixels", and the decision of "start of operation" are similar to those in Embodiment Mode 4. The decision of "set luminance" is similar to that in Embodiment Mode 8. The decision of "user decision" is similar to that in Embodiment Mode 12.

A description is made on the flow of the flow chart of FIG. **20**. In the "user decision", if the user does not determine that the process proceeds to the "burn-in correction period", the process proceeds to the "normal driving period, whereas the process proceeds to the "set luminance" if the user determines that the process proceeds to the "burn-in correction period". If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the surrounding luminance is in the predetermined range. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of all pixels". If characteristics of light-emitting elements included in all pixels are obtained in the "termination of all pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the characteristics of light-emitting elements included in all pixels are not obtained. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the surrounding luminance is in the predetermined range. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "user decision" to the conditions for proceeding from the normal driving period to the burn-in correction period, the user can decide whether the process proceeds to the burn-in correction period or not. Therefore, the decision of proceeding to the burn-in correction period is made to suit each user since frequency of using the electronic appliance or the like and the display screen or the like thereof are different depending on users.

By adding the "set luminance" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period without being effected by the surrounding luminance. In Embodiment Modes 1 to 3, one pixel or three pixels emit light at the same time and driving TFTs in the other pixels which do not emit light are in off state. Therefore, off-state current changes according to the surrounding luminance, which leads to variation in detected current value. By detecting the characteristics of the light-emitting elements included in the pixels when the surrounding luminances are the same, the effect of changes in surrounding luminance is eliminated. The surrounding luminance is preferably about 0 [cd/m^2]. In the case of a foldable mobile phone, such a state can be realized when the foldable mobile phone is folded and in the case of a digital camera, such a state can be realized when the digital camera is placed in its case.

By adding the "termination of all pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, characteristics of the light-emitting elements included in all pixels can be detected under the same conditions. When the conditions under which characteristics of the light-emitting elements included in pixels are detected, that is, when the operating environments are the same, variation in characteristics due to difference in the operating environments can be suppressed.

By adding the "set luminance" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period immediately when the surrounding luminance changes during the burn-in correction period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "set luminance" and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in the all pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period.

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **20** described in this embodiment mode, with reference to FIG. **73**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, and the driving method selection circuit **6103** are similar to those in Embodiment Mode 4. The surrounding luminance detection circuit **6501** is similar to that in Embodiment Mode 8. The start circuit **6901** is similar to that in Embodiment Mode 12.

A description is made on operation in this embodiment mode. When the user determines that the process proceeds to the burn-in correction period and the surrounding luminance detection circuit **6501** decides that the surrounding luminance of the display device is close to the predetermined luminance, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of all pixels, the reset signals **6100*a*** are inputted to the timer circuit **6901**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of user decision", the judgment of "set luminance", the judgment of "termination of all pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of user decision", the judgment of "set luminance", the judgment of "termination of all pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", the judgment of "user decision" and "set luminance" are conducted. In this case, the operation is conducted by using at least the start circuit **6901**, the surrounding luminance detection circuit **6501** and the driving method selection circuit **6103**.

Embodiment Mode 17

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **21**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", and the decision of "start of operation" are similar to those in Embodiment Mode 4. The decision of "termination of set pixels" is similar to that in Embodiment Mode 7. The decision of "set luminance" is similar to that in Embodiment Mode 8. The decision of "user decision" is similar to that in Embodiment Mode 12.

A description is made on the flow of a flow chart of FIG. **21**. In the "user decision", if the user does not determine that the process proceeds to the "burn-in correction period", the process proceeds to the "normal driving period, whereas the process proceeds to the "set luminance" if the user determines that the process proceeds to the "burn-in correction period". If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the surrounding luminance is in the predetermined range. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of set pixels". If characteristics of light-emitting elements included in the preset pixels are obtained in the "termination of set pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the characteristics of light-emitting elements included in the preset pixels are not obtained. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the surrounding luminance is in the predetermined range. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "user decision" to the conditions for proceeding from the normal driving period to the burn-in correction period, the user can decide whether the process proceeds to the burn-in correction period or not. Therefore, the decision of proceeding to the burn-in correction period is made to suit each user since frequency of using the electronic appliance or the like and the display screen or the like thereof are different depending on users.

By adding the "set luminance" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period without being effected by the surrounding luminance. In Embodiment Modes 1 to 3, one pixel or three pixels emit light at the same time and driving TFTs in the other pixels which do not emit light are in off state. Therefore, off-state current changes according to the surrounding luminance, which leads to variation in detected current value. By detecting the characteristics of the light-emitting elements included in the pixels when the surrounding luminances are the same, the effect of changes in surrounding luminance is eliminated. The surrounding luminance is preferably about 0 [cd/m^2]. In the case of a foldable mobile phone, such a state can be realized when the foldable mobile phone is folded and in the case of a digital camera, such a state can be realized when the digital camera is placed in its case.

By adding the "termination of set pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period without interrupting the burn-in correction period. In addition, it is possible that the process proceeds to the burn-in correction period selectively in a portion in which burn-in is supposed to be easily generated.

By adding the "set luminance" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period immediately when the surrounding luminance changes during the burn-in correction period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "set luminance" and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in the preset pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period.

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **21** described in this embodiment mode, with reference to FIG. **74**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, and the driving method selection circuit **6103** are similar to those in Embodiment Mode 4. The detection pixel set circuit **6106** is similar to that in Embodiment Mode 5. The surrounding luminance detection circuit **6501** is similar to that in Embodiment Mode 8. The start circuit **6901** is similar to that in Embodiment Mode 12.

A description is made on operation in this embodiment mode. When the user determines that the process proceeds to the burn-in correction period and the surrounding luminance detection circuit **6501** decides that the surrounding luminance of the display device is close to the predetermined luminance, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of the pixels set by the detection pixel set circuit **6106**, the reset signals are inputted to the start circuit **6901**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of user decision", the judgment of "set luminance", the judgment of "termination of set pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of user decision", the judgment of "set luminance", the judgment of "termination of set pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", the judgment of "user decision" and "set luminance" are conducted. In this case, the operation is conducted by using at least the start circuit **6901**, the surrounding luminance detection circuit **6501** and the driving method selection circuit **6103**.

Embodiment Mode 18

A description is made on the timing and conditions with which the process proceeds from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **22**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", the decision of "charging period", the decision of "termination of all pixels", and the decision of "start of operation" are similar to those in Embodiment Mode 4. The decision of "set luminance" is similar to that in Embodiment Mode 8. The decision of "user decision" is similar to that in Embodiment Mode 12.

A description is made on the flow of a flow chart of FIG. **22**. In the "user decision", if the user does not determine that the process proceeds to the "burn-in correction period", the process proceeds to the "normal driving period, whereas the process proceeds to the "charging period" if the user determines that the process proceeds to the "burn-in correction period". If a battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the battery is charged. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the surrounding luminance is in the predetermined range. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of all pixels". If characteristics of light-emitting elements included in all pixels are obtained in the "termination of all pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "charging period" if the characteristics of light-emitting elements included in all pixels are not obtained. If the battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the battery is charged. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the surrounding luminance is in the predetermined range. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "user decision" to the conditions for proceeding from the normal driving period to the burn-in correction period, the user can decide whether the process proceeds to the burn-in correction period or not. Therefore, the decision of proceeding to the burn-in correction period is made to suit each user since frequency of using the electronic appliance or the like and the display screen or the like thereof are different depending on users.

By adding the "charging period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period while charging the battery. In the burn-in correction period, light-emitting elements included in pixels emit light, so that characteristics of the light-emitting elements are stored as described in Embodiment Modes 1 to 3. Therefore, power consumption therein is large. Proceeding to the burn-in correction period while charging the battery can prevent reduction in power of the battery due to the burn-in correction period. Besides, when charging the battery, it is highly possible that the user has finished using the electronic appliance or the like and it is unlikely that the process returns to the normal driving period.

By adding the "set luminance" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period without being effected by the surrounding luminance. In Embodiment Modes 1 to 3, one pixel or three pixels emit light at the same time and driving TFTs in the other pixels which do not emit light are in off state. Therefore, off-state current changes according to the surrounding luminance, which leads to variation in detected current value. By detecting the characteristics of the light-emitting elements included in the pixels when the surrounding luminances are the same, the effect of changes in surrounding luminance is eliminated. The surrounding luminance is preferably about 0 [cd/m^2]. In the case of a foldable mobile phone, such a state can be realized when the foldable mobile phone is folded and in the case of a digital camera, such a state can be realized when the digital camera is placed in its case.

By adding the "termination of all pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, characteristics of the light-emitting elements included in all pixels can be detected under the same conditions. When the conditions under which characteristics of the light-emitting elements included in pixels are detected, that is, when the operating environments are the same, variation in characteristics due to difference in the operating environments can be suppressed.

By adding the "set luminance" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period immediately when the surrounding luminance changes during the burn-in correction period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "charging period", the "set luminance", and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in the all pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period.

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **22** described in this embodiment mode, with reference to FIG. **75**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, and the charging unit detection circuit **6105** are similar to those in Embodiment Mode 4. The surrounding luminance detection circuit **6501** is similar to that in Embodiment Mode 8. The start circuit **6901** is similar to that in Embodiment Mode 12.

A description is made on operation in this embodiment mode. When the user determines that the process proceeds to the burn-in correction period, and the predetermined time has passed from the input of the reset signals to the start circuit **6901**, that is, after the predetermined time has passed from the end of the last burn-in correction period, and the surrounding luminance detection circuit **6501** decides that the surrounding luminance of the display device is close to the predetermined luminance; the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of all pixels, the reset signals **6100***a* are inputted to the start circuit **6901**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of user decision", the judgment of "charging period", the judgment of "set luminance", the judgment of "termination of all pixels", and the judgment of "start of operation2 are conducted, the present invention can operate by conducting at least one of the judgment of "passage of user decision", the judgment of "charging period", the judgment of "set luminance", the judgment of "termination of all pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", the judgment of "user decision", the judgment of "charging period" and "set luminance" are conducted. In this case, the operation is conducted by using at least the start circuit **6901**, the charging unit detection circuit **6105** and the driving method selection circuit **6103**.

Embodiment Mode 19

A description is made on the timing and conditions for proceeding from the normal driving period to the burn-in correction period with reference to a flow chart of FIG. **23**, to which Embodiment Modes 1 to 3 are applied. In the flow chart, a rectangular box represents a process and a diamond-shaped box represents a decision.

In this embodiment mode, the process of "normal driving period", the process of "burn-in correction period", the decision of "charging period", the decision of "termination of all pixels", and the decision of "start of operation" are similar to those in Embodiment Mode 4. The decision of "termination of set pixels" is similar to that in Embodiment Mode 7. The decision of "set luminance" is similar to that in Embodiment Mode 8. The decision of "user decision" is similar to that in Embodiment Mode 12.

A description is made on the flow of the flow chart of FIG. **23**. In the "user decision", if the user does not determine that the process proceeds to the "burn-in correction period", the process proceeds to the "normal driving period, whereas the process proceeds to the "charging period" if the user determines that the process proceeds to the "burn-in correction period". If a battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the battery is charged. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the surrounding luminance is in the predetermined range. When the process proceeds to the "burn-in correction period", operations described in the burn-in correction period in Embodiment Modes 1 to 3 are carried out, and then, the process proceeds to the "termination of set pixels". If characteristics of light-emitting elements included in the preset pixels are obtained in the "termination of set pixels", the process proceeds to the "normal driving period", whereas the process proceeds to the "charging period" if the characteristics of light-emitting elements included in the preset pixels are not obtained. If the battery is not charged in the "charging period", the process proceeds to the "normal driving period", whereas the process proceeds to the "set luminance" if the battery is charged. If the surrounding luminance is not in the predetermined range in the "set luminance", the process proceeds to the "normal driving period", whereas the process proceeds to the "start of operation" if the surrounding luminance is in the predetermined range. If the user starts operation in the "start of operation", the process proceeds to the "normal driving period", whereas the process proceeds to the "burn-in correction period" if the user has not started operation.

By adding the "user decision" to the conditions for proceeding from the normal driving period to the burn-in correction period, the user can decide whether the process proceeds to the burn-in correction period or not. Therefore, the decision of proceeding to the burn-in correction period is made to suit each user since frequency of using the electronic appliance or the like and the display screen or the like thereof are different depending on users.

By adding the "charging period" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period while charging the battery. In the burn-in correction period, light-emitting elements included in pixels emit light, so that characteristics of the light-emitting elements are stored as described in Embodiment Modes 1 to 3. Therefore, power consumption therein is large. Proceeding to the burn-in correction period while charging the battery can prevent reduction in power of the battery due to the burn-in correction period. Besides, when charging the battery, it is highly possible that the user has finished using the electronic appliance or the like and it is unlikely that the process returns to the normal driving period.

By adding the "set luminance" to the conditions for proceeding from the normal driving period to the burn-in correction period, the process can proceed to the burn-in correction period without being effected by the surrounding luminance. In Embodiment Modes 1 to 3, one pixel or three pixels emit light at the same time and driving TFTs in the other pixels which do not emit light are in off state. Therefore, off-state current changes according to the surrounding luminance, which leads to variation in detected current value. By detecting the characteristics of the light-emitting elements included in the pixels when the surrounding luminances are the same, the effect of changes in surrounding luminance is eliminated. The surrounding luminance is preferably about 0 [cd/m^2]. In the case of a foldable mobile phone, such a state can be realized when the foldable mobile phone is folded and in the case of a digital camera, such a state can be realized when the digital camera is placed in its case.

By adding the "termination of set pixels" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period without interrupting the burn-in correction period. In addition, it is possible that the process proceeds to the burn-in correction period selectively in a portion in which burn-in is supposed to be easily generated.

By adding the "set luminance" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed to the normal driving period immediately when the surrounding luminance changes during the burn-in correction period.

By adding the "start of operation" to the conditions for proceeding from the burn-in correction period to the normal driving period, the process can proceed immediately to the normal driving period when the user is going to use the electronic appliance or the like.

If the process proceeds to the normal driving period from the burn-in correction period via the "charging period", the "set luminance", and the "start of operation", the burn-in correction period finishes before characteristics of the light-emitting elements included in the preset pixels are detected. In this case, the characteristics of light-emitting elements included in pixels which are not detected in the last burn-in correction period may be detected in the next burn-in correction period.

A description is made on the structure and operation of the controller **115** for realizing the flow chart of FIG. **22** described in this embodiment mode, with reference to FIG. **76**.

In this embodiment mode, the image signal generation circuit **6100**, the current value detection control signal generation circuit **6101**, the driving method selection circuit **6103**, and the charging unit detection circuit **6105** are similar to those in Embodiment Mode 4. The detection pixel set circuit **6106** is similar to that in Embodiment Mode 5. The surrounding luminance detection circuit **6501** is similar to that in Embodiment Mode 8. The start circuit **6901** is similar to that in Embodiment Mode 12.

A description is made on operation in this embodiment mode. When the user determines that the process proceeds to the burn-in correction period, and the predetermined time has passed from the input of the reset signals to the start circuit **6901**, that is, after the predetermined time has passed from the end of the last burn-in correction period, and the surrounding luminance detection circuit **6501** decides that the surrounding luminance of the display device is close to the predetermined luminance; the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the burn-in correction period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the burn-in correction period, respectively. In other cases, the driving method selection circuit **6103** controls the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** to conduct operation of the normal driving period. Then, the image signal generation circuit **6100** and the current value detection control signal generation circuit **6101** control the correction circuit **114** and the current value detection circuit **113** to conduct operation of the normal driving period, respectively. After detection of characteristics of the pixels set by the detection pixel set circuit **6106**, the reset signals **6100*a*** are inputted to the start circuit **6901**. In this embodiment mode, between "the normal driving period" and "the burn-in correction period", the judgment of "passage of user decision", the judgment of "charging period", the judgment of "set luminance", the judgment of "termination of set pixels", and the judgment of "start of operation" are conducted, the present invention can operate by conducting at least one of the judgment of "passage of user decision", the judgment of "charging period", the judgment of "set luminance", the judgment of "termination of set pixels", and the judgment of "start of operation". That is, for example, between "the normal driving period" and "the burn-in correction period", the judgment of "user decision", the judgment of "charging period" and "set luminance" are conducted. In this case, the operation is conducted by using at least the start circuit **6901**, the charging unit detection circuit **6105** and the driving method selection circuit **6103**.

Embodiment Mode 20

A description is made on some of the driving conditions in Embodiment Modes 1 to 3. That is, the difference in the driving conditions between the normal driving period and the burn-in correction period is described.

First, the relations among potentials of the power supply line R**105**, the power supply line G**106**, the power supply line B**107**, and the counter electrode **108** in the burn-in correction period are described.

In the case where the process proceeds to the burn-in correction period from the normal driving period, if the potentials of the power supply line R**105**, power supply line G**106**, power supply line B**107**, and the counter electrode **108** are the same in the normal driving period and in the burn-in correction period, a new power source for the burn-in correction period is not required. Therefore, the size of the circuit can be small.

In the case where the process proceeds to the burn-in correction period from the normal driving period, if the potentials of the power supply line R**105**, power supply line G**106**, and power supply line B**107** are lowered and that of the counter electrode **108** is kept the same, voltage applied to light-emitting elements included in pixels can be lowered. Therefore, deterioration in light-emitting elements included in pixels due to the burn-in correction period can be prevented and power consumption in the burn-in correction period can be reduced.

In the case where the process proceeds to the burn-in correction period from the normal driving period, if the potentials of the power supply line R**105**, power supply line G**106**, and power supply line B**107** are heightened and that of the counter electrode **108** is kept the same, voltage applied to light-emitting elements included in pixels can be heightened. Therefore, current of a power supply line can be heightened when characteristics of light-emitting elements included in pixels are obtained in the burn-in correction period. The current value of the power supply line in the burn-in correction period is small and it may be lost in the noise. When the current is increased, it is not lost in the noise and accurate current can be detected. Note that the same effect can be obtained when the potential of the power supply line R**105**, power supply line G**106**, and power supply line B**107** are kept the same and the counter electrode **108** is lowered.

Next, a description is made on the difference of driving frequency in the burn-in correction period. In the case where the process proceeds to the burn-in correction period from the normal driving period, if the driving frequency is the same in the normal driving period and in the burn-in correction period, a new clock period for the burn-in correction period is not required. Therefore, the size of the circuit can be small.

In the case where the process proceeds to the burn-in correction period from the normal driving period, if the driving frequency is lowered, a time for detecting a current value of each pixel can be set longer. Therefore, video signals can be inputted to pixels with accuracy. Light-emitting elements included in pixels move to a steady state from a transient state. Therefore, it is preferable that a current value be detected when the characteristics of the light-emitting elements included in the pixels are in a steady state in order to detect a current value of each pixel with accuracy. When the driving frequency is lowered, characteristics of pixels included in the light-emitting element can be detected in a sufficient steady state.

In the case where the process proceeds to the burn-in correction period from the normal driving period, if the driving frequency is heightened, a time for detecting a current value of each pixel can be shortened and the burn-in correction period can be shortened. Thus, it becomes less likely that the process proceeds to the normal driving period before characteristics of light-emitting elements included in all pixels or preset pixels are detected.

Embodiment Mode 21

A description is made on an example of the structure of the pixel **109** described in Embodiment Modes 1 to 3 with reference to FIG. **47**. As for the structures of the parts other than the pixel **109**, structures which can satisfy a pixel structure and a driving method described in this embodiment mode can be employed.

On or off of a selection transistor **4702** is controlled using the gate signal line **4707**. When the selection transistor **4702** turns on, video signals are inputted to a capacitor **4703** from a source signal line **4706**. Then, a driving transistor **4701** turns on/off according to the video signals. When the driving transistor **4701** turns on, current flows from a power supply line **4705** to a counter electrode through the driving transistor **4701** and a light-emitting element **4704**. When the driving transistor **4701** turns off, current does not flow. Note that one electrode of the light-emitting element **4704** is connected to either a source or a drain of the driving transistor **4701**, and the other electrode of the light-emitting element **4704** serves as the counter electrode.

Above driving method is digital driving in which a video signal has a binary value and the driving transistor **4701** serves as a switch. In digital driving, the driving transistor **4701** can operate in a linear region or a saturation region. When the driving transistor **4701** operates in a linear region, the potential of the power supply line **4705** is applied to one electrode of the light-emitting element **4704** almost as it is. When the driving transistor **4701** operates in a saturation region, current according to a gate-source voltage of the driving transistor **4701** flows.

In this embodiment mode, analog driving can be employed as well as digital driving. In digital driving, a video signal has a binary value while in analog driving, a video signal is required to have the same number of values as the number of gray scales to be expressed. By driving the driving transistor **4701** in a saturation region and changing the gate voltage of the driving transistor according to the video signals, current according to the video signals can be applied to the light-emitting element **4704**.

Note that the capacitor **4703** holds a gate potential of the driving transistor **4701**. Therefore, the capacitor **4703** is connected between a gate of the driving transistor **4701** and the power supply line **4705**; however, the present invention is not limited thereto. The capacitor **4703** is only required to be disposed so as to be able to hold the gate potential of the driving transistor **4701**. In a case where the gate potential of the driving transistor **4701** can be held using the gate capacitance of the driving transistor **4701** or the like, the capacitor **4703** may be omitted.

The selection transistor **4702** serves as a switch connected between the source signal line **4706** and the gate of the driving transistor **4701**. In FIG. **47**, an n-channel transistor is used as the selection transistor **4702**; however, the present invention is not limited thereto. Any element having a function of connecting/disconnecting the source signal line **4706** and the gate of the driving transistor **4701** may be employed. Therefore, a p-channel transistor may be employed. In that case, a potential of the gate signal line **4707** is inverted.

Embodiment Mode 22

A description is made on an example of a structure of the pixel **109** described in Embodiment Modes 1 to 3 with reference to FIG. **50**. As for the structures of the parts other than the pixel **109**, structures which can satisfy a pixel structure and a driving method described in this embodiment mode can be employed.

On or off of a selection transistor **5002** is controlled using the gate signal line **5007**. When the selection transistor **5002** turns on, video signals are inputted to a capacitor **5003** from a source signal line **5006**. Then, a driving transistor **5001** turns on/off according to the video signals. When the driving transistor **5001** turns on, current flows from a power supply line **5005** to a counter electrode through the driving transistor **5001** and a light-emitting element **5004**. When the driving transistor **5001** turns off, current does not flow. Note that one electrode of the light-emitting element **5004** is connected to either a source or a drain of the driving transistor **5001**, and the other electrode of the light-emitting element **5004** serves as a counter electrode.

Above driving method is digital driving in which a video signal has a binary value and the driving transistor **5001** serves as a switch. In digital driving, the driving transistor **5001** can operate in a linear region or a saturation region. When the driving transistor **5001** operates in a linear region, the potential of the power supply line **5005** is applied to one electrode of the light-emitting element **5004** almost as it is. When the driving transistor **5001** operates in a saturation region, current according to a gate-source voltage flows.

In this embodiment mode, analog driving can be employed as well as digital driving. In digital driving, a video signals has a binary value while in analog driving, a value signal is required to have the same number of values as the number of gray scales to be expressed. By driving the driving transistor **5001** in a saturation region and changing the gate voltage of the driving transistor according to the video signals, current according to the video signals can be applied to the light-emitting element **5004**.

Note that the capacitor **5003** holds the gate potential of the driving transistor **5001**. Therefore, the capacitor **5003** is connected between a gate of the driving transistor **5001** and one electrode of the light-emitting element **5004**; however, the present invention is not limited thereto. The capacitor **5003** is only required to be disposed so as to be able to store the gate potential of the driving transistor **5001**. In a case where the gate potential of the driving transistor **5001** can be held using the gate capacitance of the driving transistor **5001** or the like, the capacitor **5003** may be omitted.

In this embodiment mode, both the selection transistor **5002** and the driving transistor **5001** are n-channel transistors. With such a structure, amorphous silicon can be used, so that a low cost and a large screen can be easily realized. Note that there are problems with amorphous silicon such that a transistor is deteriorated, that is, the characteristics of the transistor change with time, which is called a threshold value shift. To solve such a phenomenon, it is necessary to employ a pixel structure in which a threshold value is corrected or a pixel structure in which video signals are inputted as current. However, when employing a pixel structure in which a threshold value is corrected, there arise other problems such that the number of transistors increases and so the aperture ratio of pixels is lowered, or a potential of the power supply line **5005** or the counter electrode is lowered, which leads to reduction in duty ratio of the light-emitting element **5004**. The reduction in aperture ratio and duty ratio requires increase in luminance of the light-emitting element **5004**. Therefore, the light-emitting element deteriorates earlier and the lifetime of the display device is shortened. On the other hand, when the driving method of Embodiment Modes 1 to 3 of the present invention is employed, change in characteristics of the driving transistor **5001** can be corrected as well as the deterioration in light-emitting element **5004**, at the same time. Note that duty ratio represents a driving condition of a light-emitting element, and which is a ratio of a light-emitting period to a certain period (including either or both light-emitting period and non-light-emitting period).

Therefore, combination of the driving method in Embodiment Modes 1 to 3 and a pixel structure using amorphous silicon can cause further effect. Besides, since a controller for driving a display device using amorphous silicon is generally externally provided, and the display device using amorphous silicon often has a large or medium size, so that a rate of cost for implementing the present invention to the cost for the whole display device is low when implementing the present invention in such a display device, as compared with implementing the present invention in a mobile phone or a digital camera.

Embodiment Mode 23

In a case of digital driving, only a binary value of a light-emitting state and a non-light-emitting state can be expressed as described in Embodiment Modes 21 and 22. Accordingly, another method may be used in combination to achieve multi-gray scale. A driving method for a pixel in the case where multi-gray scale is achieved is described.

To achieve multi-gray scale, a time gray scale method can be given. The time gray scale method is a method for expressing a gray scale by changing the length of light-emitting time during a certain period. In a digital time gray scale method, one-frame period is divided into a plurality of sub-frame periods. Then, a gray scale is expressed by changing the length of a lighting period during each sub-frame period.

FIG. **53** shows a timing chart in a case where a period where signals are written to a pixel (a writing period) and a period where light is emitted (a lightening time) are separated. First, signals for one screen are inputted to all pixels in a writing period. During this period, pixels do not emit light. After the writing period, a lighting period starts and pixels emit light. Next, a next sub-frame starts and signals for one screen are inputted to all pixels in a writing period. During this period, pixels do not emit light. After the writing period, a lighting period starts and pixels emit light.

In this case, a pixel structure shown in FIGS. **47** and **50** may be employed.

In a writing period, it is necessary that charge is not supplied to the light-emitting element or negative bias is applied to the light-emitting element. Specifically, potentials of the power supply line **4705**, the power supply line **5005**, and a counter electrode are controlled, so that positive bias is not supplied to the light-emitting element **4704** and the light-emitting element **5004**. Alternatively, the counter electrode may be in a floating state without being supplied with charge. As a result, the light-emitting element **4704** and the light-emitting element **5004** can be prevented from lighting in the writing period.

Next, FIG. **54** shows a timing chart in a case where a period in which a signal is written to a pixel and a period in which light is emitted are not separated. Immediately after a signal is written to each row, a lighting period starts.

In a certain row, after writing of signals and a predetermined lighting period are completed, a signal writing operation starts in a next sub-frame. By repeating such operations, each length of the lighting periods can be controlled.

In this manner, many sub-frames can be arranged in one frame even if signals are written slowly. In addition, since a ratio of a lighting period to one-frame period (a so-called duty ratio) can be high, it is possible to reduce power consumption, suppress deterioration of the light-emitting element, or suppress a pseudo contour.

In that case, a pixel structure shown in FIGS. **47** and **50** may be employed. In this case, where a time is ta in FIG. **54**, it is necessary to input signals into pixels of three rows at the same time. In general, it is impossible to input signals into pixels of a plurality of rows at the same time. Thus, as shown in FIG. **56**, one gate selection period is divided into a plurality of periods (three in FIG. **56**). Each gate signal line **4707** and gate signal line **5007** are selected in each of the divided selection periods and a corresponding signals are inputted to the source signal line **4706** and the source signal line **5006**. For example, in one gate selection period, an i-th row is selected in G**1**(ta), a j-th row is selected in G**2**(ta), and a k-th row is selected in G**3**(ta). Accordingly, an operation can be performed as if the three rows were selected at the same time in the one gate selection period.

Note that although FIGS. **54** and **56** each shows the case where signals are inputted to pixels of three rows at the same time, the present invention is not limited thereto. A signal may also be inputted to more rows or less rows.

FIG. **55** shows a timing chart in a case where signals in pixels are erased. In each row, a signal writing operation is performed and the signal in the pixel is erased before a next signal writing operation. According to this, the length of a lighting period can be easily controlled.

In a certain row, after writing of signals and a predetermined lighting period are completed, a signal writing operation starts in the next sub-frame. In a case where a lighting period is short, a signal erasing operation is performed to provide a non-light-emitting state. By repeating such operations, the lengths of the lighting periods can be controlled.

In this manner, many sub-frames can be arranged in one frame even if signals are written slowly. In addition, when an erasing operation is conducted, it is not necessary to obtain data for erasing and video signals, therefore, driving frequency of a source driver can be lowered.

Embodiment Mode 24

A description is made on a pixel structure for realizing the timing chart of FIG. **55** described in Embodiment Mode 23 with reference to FIG. **48**.

On or off of a selection transistor **4802** is controlled using a gate signal line **4807**. When the selection transistor **4802** turns on, video signals are inputted to a capacitor **4803** from a source signal line **4806**. Then, a driving transistor **4801** turns on/off according to the video signals. When the driving transistor **4801** turns on, current flows from a power supply line **4805** to a counter electrode through the driving transistor **4801** and a light-emitting element **4804**. When the driving transistor **4801** turns off, current does not flow. Note that one electrode of the light-emitting element **4804** is connected to either a source or a drain of the driving transistor **4801**, and the other electrode of the light-emitting element **4804** serves as the counter electrode.

When it is desired to erase a signal, an erasing gate signal line **4809** is selected to turn an erasing transistor **4808** on, so that the driving transistor **4801** is turned off. Then, no current flows from the power supply line **4805** to the counter electrode through the driving transistor **4801** and the light-emitting element **4804**. Consequently, a non-lighting period can be provided and the length of a lighting period can be freely controlled.

Note that the capacitor **4803** holds the gate potential of the driving transistor **4801**. Therefore, the capacitor **4803** is connected between a gate of the driving transistor **4801** and the power supply line **4805**; however, the present invention is not limited thereto. The capacitor **4803** is only required to be disposed so as to be able to hold the gate potential of the driving transistor **4801**. In a case where the gate potential of the driving transistor **4801** can be held using the gate capacitance of the driving transistor **4801** or the like, the capacitor **4803** may be omitted.

The selection transistor **4802** serves as a switch connected between the source signal line **4806** and the gate of the driving transistor **4801**. The erasing transistor **4808** serves as a switch connected between the power supply line **4805** and the gate of the driving transistor **4801**. In FIG. **48**, an n-channel transistor is used as the selection transistor **4802**; however, the present invention is not limited thereto. Any element having a function of connecting/disconnecting the source signal line **4806** and the gate of the driving transistor **4801** may be employed. Therefore, a p-channel transistor may be employed. In that case, a potential of the gate signal line **4807** is inverted.

Although the erasing transistor **4808** is used in FIG. **48**, another method can be used as well. This is because, in order to forcibly provide a non-lighting period, it is only required that current be prevented from being supplied to the light-emitting element **4804**. Therefore, a non-lighting period may be provided by disposing a switch somewhere in a path where current flows from the power supply line **4805** to the counter electrode through the driving transistor **4801** and the light-emitting element **4804**, and by controlling on/off of the switch. Alternatively, a gate-source voltage of the driving transistor **4801** may be controlled to forcibly turn off the driving transistor.

A description is made on a pixel structure in which a driving transistor is forcibly turned off using a diode with reference to FIG. **49**.

On or off of a selection transistor **4902** is controlled using a gate signal line **4907**. When the selection transistor **4902** turns on, video signals are inputted to a capacitor **4903** from a source signal line **4906**. Then, a driving transistor **4901** turns on/off according to the video signals. When the driving transistor **4901** turns on, current flows from a power supply line **4905** to a counter electrode through the driving transistor **4901** and a light-emitting element **4904**. When the driving transistor **4901** turns off, current does not flow. Note that one electrode of the light-emitting element **4904** is connected to either a source or a drain of the driving transistor **4901**, and the other electrode of the light-emitting element **4904** serves as the counter electrode.

When it is desired to erase a signal, the erasing gate signal line **4909** is selected (here, supplied with a potential equal to or higher than the power supply line **4905**) to turn the erasing diode **4908** on, so that current flows from the erasing gate signal line **4909** to the gate of the driving transistor **4901**. Consequently, the driving transistor **4901** is turned off. Then, no current flows from the power supply line **4905** to the counter electrode through the driving transistor **4901** and the light-emitting element **4904**. Consequently, a non-lighting period can be provided and the length of a lighting period can be freely controlled.

When it is desired to hold a signal, the erasing gate signal line **4909** is not selected (here, supplied with a low potential). Then, the erasing diode **4908** is turned off and the gate potential of the driving transistor **4901** is thus held.

Note that the erasing diode **4908** may be any element as far as it has a rectifying property. The erasing diode **4908** may be a PN diode, a PIN diode, a Schottky diode, or a Zener diode.

In addition, a diode-connected transistor (a gate and a drain thereof are connected) may be used as well. As the erasing diode **4908**, a diode-connected transistor is used. An n-channel transistor may be used and a p-channel transistor may also be used.

Note that the capacitor **4903** holds the gate potential of the driving transistor **4901**. Therefore, the capacitor **4903** is connected between a gate of the driving transistor **4901** and the power supply line **4905**; however, the present invention is not limited thereto. The capacitor **4903** is only required to be disposed so as to be able to store the gate potential of the driving transistor **4901**. In a case where the gate potential of the driving transistor **4901** can be held using the gate capacitance of the driving transistor **4901** or the like, the capacitor **4903** may be omitted.

Embodiment Mode 25

A description is made on a pixel structure for realizing the timing chart of FIG. **55** described in Embodiment Mode 23 with reference to FIG. **51**.

On or off of a selection transistor **5102** is controlled using a gate signal line **5107**. When the selection transistor **5102** turns on, video signals are inputted to a capacitor **5103** from a source signal line **5106**. Then, a driving transistor **5101** turns on/off according to the video signals. When the driving transistor **5101** turns on, current flows from a power supply line **5105** to a counter electrode through the driving transistor **5101** and a light-emitting element **5104**. When the driving transistor **5101** turns off, current does not flow. Note that one electrode of the light-emitting element **5104** is connected to either a source or a drain of the driving transistor **5101**, and the other electrode of the light-emitting element **5104** serves as the counter electrode.

When it is desired to erase a signal, an erasing gate signal line **5109** is selected to turn an erasing transistor **5108** on, so that the driving transistor **5101** is turned off. Then, no current flows from the power supply line **5105** to the counter electrode through the driving transistor **5101** and the light-emitting element **5104**. Consequently, a non-lighting period can be provided and the length of a lighting period can be freely controlled.

Note that the capacitor **5103** holds the gate potential of the driving transistor **5101**. Therefore, the capacitor **5103** is connected between a gate of the driving transistor **5101** and the power supply line **5105**; however, the present invention is not limited thereto. The capacitor **5103** may be disposed so as to be able to store the gate potential of the driving transistor **5101**. In a case where the gate potential of the driving transistor **5101** can be held using the gate capacitance of the driving transistor **5101** or the like, the capacitor **5103** may be omitted.

Although the erasing transistor **5108** is used in FIG. **51**, another method can be used as well. This is because, in order to forcibly provide a non-lighting period, it is only required that current be prevented from being supplied to the light-emitting element **5104**. Therefore, a non-lighting period may be provided by disposing a switch in a path where current flows from the power supply line **5105** to the counter electrode through the driving transistor **5101** and the light-emitting element **5104**, and by controlling on/off of the switch. Alternatively, a gate-source voltage of the driving transistor **5101** may be controlled to forcibly turn off the driving transistor.

A description is made on a pixel structure in which a driving transistor is forcibly turned off using a diode with reference to FIG. **52**.

On or off of a selection transistor **5202** is controlled using the gate signal line **5207**. When the selection transistor **5202** turns on, video signals are inputted to a capacitor **5203** from a source signal line **5206**. Then, a driving transistor **5201** turns on/off according to the video signals. When the driving transistor **5201** turns on, a current flows from a power supply line **5205** to a counter electrode through the driving transistor **5201** and a light-emitting element **5204**. When the driving transistor **5201** turns off, current does not flow. Note that one electrode of the light-emitting element **5204** is connected to either a source or a drain of the driving transistor **5201**, and the other electrode of the light-emitting element **5204** serves as the counter electrode.

When it is desired to erase a signal, the erasing gate signal line **5209** is selected (here, supplied with a low potential) to turn the erasing diode **5208** on, so that current flows from the gate of the driving transistor **5201** to the erasing gate signal line **5209**. Consequently, the driving transistor **5201** is turned off. Then, no current flows from the power supply line **5205** to the counter electrode through the driving transistor **5201** and the light-emitting element **5204**. Consequently, a non-lighting period can be provided and the length of a lighting period can be freely controlled.

When it is desired to hold a signal, the erasing gate signal line **5209** is not selected (here, supplied with a high potential). Then, the erasing diode **5208** is turned off and the gate potential of the driving transistor **5201** is thus held.

Note that the erasing diode **5208** may be any element as far as it has a rectifying property. The erasing diode **5208** may be a PN diode, a PIN diode, a Schottky diode, or a Zener diode.

In addition, a diode-connected transistor (a gate and a drain thereof are connected) may be used as well. As the erasing diode **5208**, a diode-connected transistor is used. In this embodiment mode an n-channel transistor may be used.

Note that the capacitor **5203** holds the gate potential of the driving transistor **5201**. Therefore, the capacitor **5203** is connected between a gate of the driving transistor **5201** and the power supply line **5205**; however, the present invention is not limited thereto. The capacitor **5203** may be disposed so as to be able to store the gate potential of the driving transistor **5201**. In a case where the gate potential of the driving transistor **5201** can be held using the gate capacitance of the driving transistor **5201** or the like, the capacitor **5203** may be omitted.

In this embodiment mode, the selection transistor **5102**, the erasing transistor **5108**, and the driving transistor **5101** are n-channel transistors in FIG. **51**. In FIG. **52**, the selection transistor **5202**, the erasing transistor **5208**, and the driving transistor **5201** are n-channel transistors. With such a structure, amorphous silicon can be used, so that a low cost and a large screen can be easily realized. Note that there are problem with amorphous silicon such that the transistor is deteriorated, that is, the characteristics of the transistor change with time, which is called a threshold value shift. To solve such a phenomenon, it is necessary to employ a pixel structure in which a threshold value is corrected or a pixel structure in which video signals are inputted as current. However, when employing a pixel structure in which a threshold value is corrected, there arise other problems such that the number of transistor increases, so that the aperture ratio of pixels is lowered, or a potential of the power supply line **5105** or the counter electrode is lowered, which leads to reduction in duty ratio of the light-emitting element **5104**. The reduction in aperture ratio and duty ratio requires increase in luminance of the light-emitting element **5104**. Therefore, the light-emitting element **5104** deteriorates earlier and the lifetime of the display device is shortened.

On the other hand, when the driving method of Embodiment Modes 1 to 3 of the present invention is employed, change in characteristics of the driving transistors **5101** and **5201** can be corrected as well as the deterioration in light-emitting elements **5104** and **5204**, at the same time.

Therefore, combination of the driving method in Embodiment Modes 1 to 3 and a pixel structure using amorphous silicon can cause further effect. Besides, since a controller for driving a display device using amorphous silicon is generally externally provided, and the display device using amorphous silicon has often a large or medium size, so that a rate of cost for implementing the present invention to the cost for the whole display device is low when implementing the present invention in such a display device, compared with implementing the present invention in a mobile phone or a digital camera.

Note that a driving method as shown in FIG. **55** can be achieved using the circuits in FIGS. **47** and **50** as other circuits. A timing chart shown in FIG. **56** may be applied in this case. As shown in FIG. **56**, one gate selection period is divided into three; however, here, one gate selection period is divided into two. Each gate line is selected in each of the divided selection periods and a corresponding signal (a video signal and an erasing signal) is inputted to the source signal lines **4706** and **5006**. For example, in one gate selection period, an i-th row is selected in the first half of the period and a j-th row is selected in the latter half of the period. Then, when the i-th row is selected, a video signal therefor is inputted. On the other hand, when the j-th row is selected, a signal for turning the driving transistor off is inputted. Accordingly, an operation can be performed as if the two rows are selected at the same time in the one gate selection period.

Note that the timing chart, the pixel structure, and the driving method are examples and the present invention is not limited thereto. The present invention can be applied to various timing charts, pixel structures, and driving methods.

Embodiment Mode 26

In this embodiment mode, description is made on structures and operations of a display device, a source driver, a gate driver, and the like.

As shown in FIG. **45** A, a display device includes a pixel portion **3401**, a gate driver **3402**, and a source driver **3403**.

The gate driver **3402** sequentially outputs selection signals to the pixel portion **3401**. FIG. **45**B shows an example of a structure of the gate driver **3402**. The gate driver includes a shift register **3404**, a buffer circuit **3405**, and the like. The shift register **3404** sequentially outputs pulses so as to select sequentially. Note that the gate driver **3402** further includes a level shifter circuit, a pulse width controlling circuit, or the like in many cases.

The source driver **3403** sequentially outputs video signals to the pixel portion **3401**. The pixel portion **3401** displays an image by controlling the state of light in accordance with the video signals. The video signals inputted from the source driver **3403** to the pixel portion **3401** are often voltage. That is, a display element and an element for controlling the display element which are disposed in each pixel are changed in states by video signals (voltage) inputted from the source driver **3403**. As an example of the display element disposed in each pixel, an EL element, an element used for an FED (field emission display), a liquid crystal, a DMD (digital micromirror device), and the like can be given.

Note that each of the gate driver **3402** and the source driver **3403** may be provided more than one.

In particular, in the case of using the driving method shown in Embodiment Mode 22, where one gate selection period is divided into a plurality of subgate selection periods, as many gate drivers as the division number of one gate selection period are usually required. In addition, such a gate driver may be employed that has a function of selecting an arbitrary gate line at arbitrary timing as well as performing a sequential scan operation, as typified by a gate driver using a decoder.

Here, description is made with reference to FIG. **57** on an example of a structure of a display device in the case of using gate drivers as many as the division number of one gate selection period. Note that the present invention is not limited to this circuit structure, and any circuit having a similar function may be used. In addition, although FIG. **57** shows a gate driver in the case of dividing one gate selection period into three as an example, the division number of one gate selection period is not limited to three and it may be any number. For example, in the case of dividing one gate selection period into four, four shift registers are required in total for the gate driver.

FIG. **57** shows an example where a gate driver has three shift registers **5701**, **5702**, and **5703** provided on opposite sides of a pixel portion **5700**. In the case of inputting outputs of these shift registers to one gate line from its opposite sides, the switch groups **5708** and **5709** are required so that the gate line will not receive an output from one of the shift registers while receiving an output from the other shift register, in order to prevent that the two outputs are inverted to each other, which would result in short circuit. While the switch group **5708** is on, the switch **5709** is off, while the switch group **5709** is on, the switch **5708** is off. When one of the second shift register **5702** and the third shift register **5703** is selected by an OR circuit **5707**, a gate line connected to an end of the shift register is also selected. In this case, since both of the second shift registers are connected to each input terminal of the OR circuit **5707**, short circuit of a power source can be prevented, which would otherwise be caused in the case where two signals are inputted. Reference symbols G_CP**1**, G_CP**2**, and G_CP**3** are pulse width control signals. The output from G_CP**1** and the first shift register **5701** are connected to input of an AND circuit **5704**. When the output from the first shift register **5701** and G_CP**1** are in a selected state, the gate signal line connected therefrom is in a selected state. The output from G_CP**2** and the first shift register **5701** are connected to input of an AND circuit **5705**. When the output from the second shift register **5702** and G_CP**2** are in a selected state, the gate signal line connected therefrom is in a selected state. The output from G_CP3 and the first shift register **5703** are connected to input of an AND circuit **5706**. When the output from the third shift register **5703** and G_CP**3** are in a selected state, the gate signal line connected therefrom is in a selected state. As for a signal width of the shift registers, each of the three shift registers is set to have the same signal width as the width of one gate selection period, but it is changed into a pulse width which is to be actually outputted to a gate line (divided into three in this case) by using a pulse width control signal, thereby such a driving method can be performed that one gate selection period is divided into a plurality of subgate selection periods.

FIG. **44** shows a gate driver with a structure where an output of shift registers are provided to one side of a pixel portion, with the condition that one gate selection period is divided into three. Since no switch for preventing short circuit of a display element is provided on opposite sides of the pixel portion in the structure in FIG. **44**, more stable operation can be expected as compared to the operation of a gate driver with a structure where shift registers are provided on opposite sides of the pixel portion. Note that the division number of one gate selection period is not limited to three, and it may be any number.

Note that the details of such a driving method are disclosed in Japanese Patent Laid-Open No. 2002-215092, Japanese Patent Laid-Open No. 2002-297094, and the like, the content of which can be combined with the present invention.

An example of a structure of a display device which has a decoder type gate driver is described.

FIG. **58** shows an example of a decoder type gate driver **5800**. Reference numeral **5808** denotes a pixel portion, reference numeral **5800** denotes a gate driver, reference numeral **5807** denotes a source driver. Here, description is made on the case where 15 gate lines are driven with a 4-bit decoder. The number of bits of the decoder is appropriately determined in accordance with the number of gate signal lines of a display device. For example, when the number of gate lines is 60, it is effective to select a 6-bit decoder since $2^6=64$. Similarly, when the number of gate lines is 240, it is effective to select an 8-bit decoder since $2^8=256$. In this manner, it is effective to select a decoder having a larger number of bits than the number obtained by extracting a square root of the number of gate lines; however, the present invention is not limited to this.

As the operation of the decoder shown in FIG. **58**, there are the following operations. In the case of selecting a gate signal line **1**, (1, 0, 0, 0) are inputted to first to fourth input terminals **5801** to **5804**, respectively. In the case of selecting a gate signal line **2**, (0, 1, 0, 0) are inputted. In the case of selecting a gate signal line **3**, (1, 1, 0, 0) are inputted. In this manner, by assigning one combination of digital signals to one gate line, an arbitrary gate line can be selected at arbitrary timing.

In the case where the number of input terminals of a NAND circuit is large, the operation might be affected by the resistance of a transistor or the like. In such a case, the NAND circuit having a large number of terminals may be replaced by a digital circuit having a similar function and less input terminals, as shown in FIG. **59**. Reference numeral **5908** denotes a pixel portion, reference numeral **5900** denotes a gate driver, reference numeral **5907** denotes a source driver. The gate driver **5900** using a decoder shown in FIG. **59** operates as follows. In the case of selecting a gate signal line **1**, (1, 0, 0, 0) are inputted to first to fourth input terminals **5901** to **5904**, respectively. In the case of selecting a gate signal line **2**, (0, 1, 0, 0) are inputted. In the case of selecting a gate signal line **3**, (1, 1, 0, 0) are inputted. In this manner, by assigning one combination of digital signals to one gate line, an arbitrary gate line can be selected at arbitrary timing.

FIG. **58** shows an example in which a level shifter **5805** and a buffer circuit **5806** for impedance matching are used in an output portion of the decoder, and FIG. **59** shows an example in which a level shifter **5905** and a buffer circuit **5906** for impedance matching are used in an output portion of the decoder. Note that as long as a similar function is provided, the structure of the gate driver using a decoder is not limited thereto.

FIG. **45**C shows an example of a structure of a source driver **3403**. The source driver **3403** includes a shift register **3406**, a first latch circuit (LAT**1**) **3407**, a second latch circuit (LAT**2**) **3408**, a level shifter **3409**, and the like. The level shifter **3409** may have a function to convert digital signals to analog signals as well as a gamma correction function.

Each pixel has a display element such as a light-emitting element. There may be a case where a circuit for outputting current (video signal) to the display element, namely a current source circuit is provided.

Next, the operation of the source driver **3403** is described briefly. Clock signals (S-CLK), start pulses (S-SP), and inverted clock signals (S-CLKb) are inputted to the shift register **3406**, and in accordance with the input timing of these signals, the shift register **3406** sequentially outputs sampling pulses.

The sampling pulses outputted from the shift register **3406** are inputted to the first latch circuit (LAT**1**) **3407**. Video signals are inputted from a video signal line **3410** to the first latch circuit (LAT**1**) **3407**, and these video signals are held in each column in accordance with the input timing of the sampling pulses.

After holding of video signals are completed up to the last column in the first latch circuit (LAT**1**) **3407**, latch pulses are inputted from a latch control line **3411**, and the video signals which have been held in the first latch circuit (LAT**1**) **3407** are transferred to the second latch circuit (LAT**2**) **3408** all at once in a horizontal flyback period. After that, the video signals of one row, which have been held in the second latch circuit (LAT**2**) **3408**, are inputted to the level shifter **3409** all at once. A signal which is outputted from the level shifter **3409** is inputted to the pixel portion **3401**.

While video signals held in the second latch circuit (LAT**2**) **3408** are inputted to the level shifter **3409**, and then inputted to the pixel portion **3401**, the shift register **3406** outputs sampling pulses again. That is, two operations are performed at the same time. Accordingly, line sequential driving can be performed. Hereafter, such operations are repeated.

Next, description is made on a source driver in the case of using a timing chart where address periods and lighting periods are not separated from each other as described in Embodiment Modes 22 and 25. Here, two examples are described. The first example is a method of increasing the driving frequency of the source driver **3403** without changing the structure of the source driver **3403** shown in FIG. **45**. If address periods and lighting periods are not separated from each other, the source driver **3403** performs writing of one line in each subgate selection period in FIG. **56**. That is, in the case of dividing one gate selection period into two, such driving that address periods and lighting periods are not separated from each other can be performed by increasing the driving frequency of the source driver **3403** to be twice as large, compared to that in the pre-divided gate selection period. Similarly, in the case of dividing one gate selection period into three, the foregoing operation can be performed by increasing the driving frequency to be three times as large, and in the case of dividing one gate selection period into n, the foregoing operation can be performed by increasing the driving frequency to be n times as large. This method is advantageous in that the structure of the source driver is not particularly modified and is simple.

Next, the second example is described. FIG. **60** shows a structure of a source driver of the second example. Reference numeral **6001** denotes a pixel portion, reference numeral **6002** denotes a gate driver, reference numeral **6003** denotes a source driver. First, an output of a shift register **6006** is inputted to both a first latch circuit A**6007** and a first latch circuit B**6012**. Note that although the output is inputted to the two first latch circuits A and B in this example, the number is not limited to two, and any number of first latch circuits may be provided. In addition, although an output of one shift register is inputted to a plurality of the first latch circuits in order to suppress an increase in circuit scale, the number of the shift registers is not limited to one, and any number of shift registers may be provided.

Video Data-A and Vide Data-B are inputted to the first latch circuit A**6007** and the first latch circuit B**6012** as video signals, respectively. The video signals are latched with an output of the shift register, and then the signals are outputted to second latch circuits. In each of second latch circuits A**6012** and B**6013**, video signals for one line are held, and the data held therein is updated at the timing specified by Latch Pulse-A and Latch Pulse-B. Outputs of the second latch circuits A**6012** and B**6013** are each connected to a switch **6014** which can select either signals from the second latch circuit A**6008** or signals from the second latch circuit B**6013** to be inputted to a pixel portion. That is, in the case of writing video signals to pixels by dividing one gate selection period into two, such driving that one gate selection period is divided into two can be performed by outputting signals from the second latch circuit A**6008** in the first half of the one gate selection period, and outputting signals from the second latch circuit B**6013** in the second half of the one gate selection period. In this case, the driving frequency of the source driver **6003** can be kept about the same as compared to the structure shown in FIG. **45** where the first and second latch circuits are provided one by one. In addition, in the case of performing driving, for example, such that one gate selection period is divided into four with the structure in FIG. **45**, the driving frequency of the source driver **6003** is increased to be four times as large, compared to the case where the gate selection period is not divided, whereas in the structure in FIG. **60**, the driving frequency of the source driver **6003** is only required to be increased twice as large. That is, the structure of the source driver **6003** in FIG. **60** is advantageous as compared to the structure in FIG. **45** in power consumption, yield, reliability, and the like.

Note that the source driver or a part of it (e.g., a current source circuit, a level shifter, or the like) is not necessarily provided over the same substrate as the pixel portion **3401**, and may be constructed with an external IC chip.

Note that the structures of the source driver and the gate driver are not limited to those in FIGS. **45** and **60**. For example, there is a case where signals are supplied to pixels by a dot sequential driving method. FIG. **46** shows an example of a source driver **3503** in that case. The source driver **3503** includes a shift register **3504** and a sampling circuit **3505**. The shift register **3504** outputs sampling pulses to the sampling circuit **3505**. Video signals, which are inputted form a video signal line **3506** are inputted to a pixel portion **3501** in accordance with the sampling pulses. Then, signals are sequentially inputted to pixels of a row selected by a gate driver **3402**.

As is described already, transistors of the present invention may be any type of transistors, and formed over any substrate. Therefore, all the circuits as shown in FIGS. **45**, **46**, and **60** may be formed over a glass substrate, a plastic substrate, a single crystalline substrate, or an SOI substrate. Alternatively, a part of the circuits in FIGS. **45**, **46**, and **60** may be formed over one substrate, while another part of the circuits may be formed over another substrate. That is, not all the circuits in FIGS. **45**, **46**, and **60** are required to be formed over one substrate. For example, in FIGS. **45**, **46**, and **60**, the pixel portion **3401** and the gate driver **3402** may be formed over a glass substrate using TFTs, while the source driver **3403** (or a part thereof) may be formed over a single crystalline substrate as an IC chip, and then the IC chip may be mounted onto the glass substrate by COG (Chip On Glass) bonding. Alternatively, the IC chip may be connected to the glass substrate by TAB (Tape Auto Bonding) or with a printed substrate.

Note that the descriptions in this embodiment mode correspond to the one utilizing the descriptions in Embodiment Modes 1 to 3. Accordingly, the descriptions in Embodiment Modes 1 to 3 can be applied to this embodiment mode.

Embodiment 1

In this embodiment, description is made on an example of a pixel structure. FIGS. **24**A and **24**B are cross-sectional views of a pixel in a panel described in Embodiment Modes 21 to 25. An example where a TFT is used as a switching element provided in a pixel and a light-emitting element is used as a display medium provided in a pixel.

In this embodiment, a description is made on a display device having pixels with a structure described in embodiment modes with reference to FIGS. **47** to **52**. Examples of the structure are shown in FIGS. **1**, **3**, and **5**.

The gate signal line **4707** in FIG. **47** corresponds to the gate signal line **104** in FIGS. **1**, **3**, and **5**. The source signal line **4706** in FIG. **47** corresponds to the source signal line **103** in FIGS. **3** and **5**. The power supply line **4705** in FIG. **47** corresponds to the power supply line R**105**, the power supply line G**106**, or the power supply line B**107** in FIGS. **3** and **5**.

The gate signal line **4807** in FIG. **48** corresponds to the gate signal line **104** in FIGS. **1**, **3**, and **5**. The source signal line **4806** in FIG. **48** corresponds to the source signal line **103** in FIGS. **3** and **5**. The power supply line **4805** in FIG. **48** corresponds to the power supply line R**105**, the power supply line G**106**, or the power supply line B**107** in FIGS. **3** and **5**.

The gate signal line **4907** in FIG. **49** corresponds to the gate signal line **104** in FIGS. **1**, **3**, and **5**. The source signal line **4906** in FIG. **49** corresponds to the source signal line **103** in FIGS. **3** and **5**. The power supply line **4905** in FIG. **49** corresponds to the power supply line R**105**, the power supply line G**106**, or the power supply line B**107** in FIGS. **3** and **5**.

The gate signal line **5007** in FIG. **50** corresponds to the gate signal line **104** in FIGS. **1**, **3**, and **5**. The source signal line **5006** in FIG. **50** corresponds to the source signal line **103** in FIGS. **3** and **5**. The power supply line **5005** in FIG. **50** corresponds to the power supply line R**105**, the power supply line G**106**, or the power supply line B**107** in FIGS. **3** and **5**.

The gate signal line **5107** in FIG. **51** corresponds to the gate signal line **104** in FIGS. **1**, **3**, and **5**. The source signal line **5106** in FIG. **51** corresponds to the source signal line **103** in FIGS. **3** and **5**. The power supply line **5105** in FIG. **51** corresponds to the power supply line R**105**, the power supply line G**106**, or the power supply line B**107** in FIGS. **3** and **5**.

The gate signal line **5207** in FIG. **52** corresponds to the gate signal line **104** in FIGS. **1**, **3**, and **5**. The source signal line **5206** in FIG. **52** corresponds to the source signal line **103** in FIGS. **3** and **5**. The power supply line **5205** in FIG. **52** corresponds to the power supply line R**105**, the power supply line G**106**, or the power supply line B**107** in FIGS. **3** and **5**.

Note that other wires shown in FIGS. **47** to **52** are not shown in FIGS. **1** to **6**.

In FIGS. **24**A and **24**B, reference numeral **2400** denotes a substrate; **2401**, a base film; **2402**, a semiconductor layer; **2412**, a semiconductor layer; **2403**, a first insulating film; **2404**, a gate electrode; **2414**, an electrode; **2405**, a second insulating film; **2406**, a first electrode; **2407**, a second electrode; **2408**, a third insulating film; **2409**, a light-emitting layer; and **2417**, a third electrode. Reference numeral **2410** denotes a TFT; **2415**, a light-emitting element; and **2411**, a capacitor. In FIGS. **24**A and **24**B, the TFT **2410** and the capacitor **2411** are shown as typical examples of the elements included in a pixel. A structure of FIG. **24**A is described first.

As the substrate **2400**, a glass substrate such as barium borosilicate glass or alumino borosilicate glass, a quartz substrate, a ceramic substrate, or the like can be used. Alternatively, a metal substrate containing stainless steel or a semiconductor substrate having a surface over which an insulating film is formed can be used. A substrate formed of a flexible synthetic resin such as plastic can also be used. The surface of the substrate **2400** may be planarized by polishing such as CMP.

As the base film **2401**, an insulating film containing silicon oxide, silicon nitride, silicon nitride oxide, or the like can be used. The base film **2401** can prevent diffusion of alkali metals such as Na or alkaline earth metals contained in the substrate **2400** into the semiconductor layer **2402**, which would otherwise adversely affect the characteristics of the TFT **2410**. Although the base film **2401** is formed in a single layer in FIG. **24**A, it may have two or more layers. Note that the base film **2401** is not necessarily provided in the case where diffusion of impurities is not of a big problem, for example in the case of using a quartz substrate.

As the semiconductor layer **2402** and the semiconductor layer **2412**, a patterned crystalline semiconductor film or amorphous semiconductor film can be used. The crystalline semiconductor film can be obtained by crystallizing an amorphous semiconductor film. As the crystallization method, laser crystallization, thermal crystallization using RTA or an annealing furnace, thermal crystallization using metal elements which promote crystallization or the like can be used. The semiconductor layer **2402** includes a channel formation region and a pair of impurity regions doped with an impurity element which imparts a conductivity type. Note that another impurity region which is doped with the foregoing impurity elements so as to form a lower concentration may be provided between the channel formation region and the pair of impurity regions. The semiconductor layer **2412** may have such a structure that the entire layer is doped with an impurity element which imparts a conductivity type.

The first insulating film **2403** can be formed of silicon oxide, silicon nitride, silicon nitride oxide or the like, and formed by either a single layer or stacking a plurality of layers.

Note that the first insulating film **2403** may be formed by a film containing hydrogen so as to hydrogenate the semiconductor layer **2402**.

The gate electrode **2404** and the electrode **2414** may be formed of one element selected from Ta, W, Ti, Mo, Al, Cu, Cr, and Nd, or an alloy or a compound containing plurality of such elements, and formed by either a single layer or stacked layer structure.

The TFT **2410** is formed to have the semiconductor layer **2402**, the gate electrode **2404**, and the first insulating film **2403** sandwiched between the semiconductor layer **2402** and the gate electrode **2404**. Although FIG. **24** shows only the TFT **2410** connected to the second electrode **2407** of the light-emitting element **2415** as a TFT included in a pixel, a plurality of TFTs may be provided. In addition, although this embodiment illustrates the TFT **2410** as a top-gate transistor, the TFT **2410** may be a bottom-gate transistor having a gate electrode below a semiconductor layer, or a dual-gate transistor having gate electrodes above and below a semiconductor layer.

The capacitor **2411** is formed to have the first insulating film **2403** as a dielectric, and the semiconductor layer **2412** and the electrode **2414** as a pair of electrode facing each other with the first insulating film **2403** sandwiched therebetween. Although FIG. **24** illustrates an example of a capacitor included in the pixel, where the semiconductor layer **2412** which is formed concurrently with the semiconductor layer **2402** of the TFT **2410** is used as one of the pair of electrodes, while the electrode **2414** which is formed concurrently with the gate electrode **2404** of the TFT **2410** is used as the other electrode, the present invention is not limited to such a structure.

The second insulating film **2405** may be formed to have either a single layer or stacked layers, using an inorganic insulating film or an organic insulating film. As the inorganic insulating film, there is a silicon oxide film formed by CVD or a silicon oxide film formed by SOG (Spin On Glass). As the organic insulating film, a film formed of polyimide, polyamide, BCB (benzocyclobutene), acrylic, a positive photosensitive organic resin, a negative photosensitive organic resin, or the like can be used.

The second insulating film **2405** may also be formed of a material having a skeletal structure with the bond of silicon (Si) and oxygen (O). As a substituent of such a material, an organic group containing at least hydrogen (e.g., an alkyl group or aromatic hydrocarbon) is used. Alternatively, a fluoro group may be used as the substituent or both the fluoro group and the organic group containing at least hydrogen may be used as the substituent.

Note that the surface of the second insulating film **2405** may be nitrided by high-density plasma treatment. High-density plasma is generated by using a microwave with a high frequency of 2.45 GHz, for example. Note that as the high-density plasma, plasma with an electron density of 2415 cm^{-3} or more and an electron temperature of 0.2 to 2.0 eV (preferably, 0.5 to 1.5 eV) is used. Since the high-density plasma which has a feature of low electron temperature has low kinetic energy of activated species, a less defective film with less plasma damage can be formed as compared with that formed by a conventional plasma treatment. In performing high-density plasma treatment, the substrate **2400** is set at a temperature of 350 to 450° C. In addition, the distance between an antenna for generating microwaves and the substrate **2400** in an apparatus for generating high-density plasma is set to 20 to 80 mm (preferably, 20 to 60 mm).

The surface of the second insulating film **2405** is nitrided by performing the foregoing high-density plasma treatment under an atmosphere containing nitrogen (N) and a rare gas (at least one of He, Ne, Ar, Kr, and Xe), an atmosphere containing nitrogen, hydrogen (H), and a rare gas, or an atmosphere containing NH_3 and a rare gas. The surface of the second insulating film **2405** formed by such nitridation treatment with high-density plasma is mixed with elements such as H, He, Ne, Ar, Kr, or Xe. For example, by using a silicon oxide film or a silicon oxynitride film as the second insulating film **2405** and treating the surface of the film with high-density plasma, a silicon nitride film is formed. Hydrogen contained in the silicon nitride film formed in this manner may be used for hydrogenating the semiconductor layer **2402** of the TFT **2410**. Note that this hydrogenation treatment may be combined with the foregoing hydrogenation treatment using hydrogen contained in the first insulating film **2403**.

Note that another insulating film may be formed over the nitride film formed by the high-density plasma treatment, so as to be used as the second insulating film **2405**.

The first electrode **2406** may be formed of one element selected from Al, Ni, C, W, Mo, Ti, Pt, Cu, Ta, Au, Mn, or an alloy or compound containing plurality of such elements, and formed by either a single layer or stacked layer structure.

Either or both the second electrode **2407** and the third electrode **2417** can be formed as a transparent electrode. The transparent electrode can be formed of indium oxide containing tungsten oxide (IWO), indium oxide containing tungsten oxide and zinc oxide (IWZO), indium oxide containing titanium oxide (ITiO), indium tin oxide containing titanium oxide (ITTiO), or the like. Needless to say, indium tin oxide (ITO), indium zinc oxide (IZO), indium tin oxide to which silicon oxide is added (ITSO), or the like may be used.

The light-emitting layer is preferably formed by a plurality of layers having different functions, such as a hole injecting/transporting layer, a light-emitting layer, and an electron injecting/transporting layer.

The hole injecting/transporting layer is preferably formed of a composite material of an organic compound material having a hole transporting property and an inorganic compound material which exhibits an electron accepting property with respect to the organic compound material. By using such a structure, many hole carriers are generated in the organic compound which inherently has few carriers, thereby an excellent hole injecting/transporting property can be obtained. Due to such an effect, a driving voltage can be suppressed compared to the conventional structure. Further, since the hole injecting/transporting layer can be formed thick without increasing the driving voltage, short circuit of the light-emitting element resulting from dust or the like can be also suppressed.

As an organic compound material having a hole transporting property, there is, for example, 4,4',41'-tris[N-(3-methylphenyl)-N-phenylamino]triphenylamine (abbreviation: MTDATA); 1,3,5-tris[N,N-di(m-tolyl)amino]benzene (abbreviation: m-MTDAB); N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine (abbreviation: TPD); 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (abbreviation: NPB); or the like. However, the present invention is not limited to these materials.

As an inorganic compound material which exhibits an electron accepting property, there is, for example, titanium oxide, zirconium oxide, vanadium oxide, molybdenum oxide, tungsten oxide, rhenium oxide, ruthenium oxide, zinc oxide, or the like. In particular, vanadium oxide, molybdenum oxide, tungsten oxide, and rhenium oxide are preferable since they can be deposited in vacuum, and thus are easy to be handled.

The electron injecting/transporting layer is formed of an organic compound material having an electron transporting property. Specifically, there is tris(8-quinolinolato)aluminum (abbreviation: Alq_3), tris(4-methyl-8-quinolinolato)aluminum (abbreviation: $Almq_3$), or the like. However, the present invention is not limited to these.

The light-emitting layer can be formed of, for example, 9,10-di(2-naphthyl)anthracene (abbreviation: DNA); 9,10-di(2-naphthyl)-2-tert-butylanthracene (abbreviation: t-BuDNA); 4,4'-bis(2,2-diphenylvinyl)biphenyl (abbreviation: DPVBi); coumarin 30; coumarin 6; coumarin 545; coumarin 545T; perylene; rubrene; periflanthene; 2,5,8,11-tetra(tert-butyl)perylene (abbreviation: TBP); 9,10-diphenylanthracene (abbreviation: DPA); 5,12-diphenylanthracene; 4-(dicyanomethylene)-2-methyl-(p-dimethylaminostyryl)-4H-pyran (abbreviation: DCM1); 4-(dicyanomethylene)-2-methyl-6-[2-(julolidine-9-yl)ethenyl]-4H-pyran (abbreviation: DCM2); 4-(dicyanomethylene)-2,6-bis[p-(dimethylamino)styryl]-4H-pyran (abbreviation: BisDCM); or the like. Alternatively, the following compounds capable of generating phosphorescence can be used: bis[2-(4',6'-difluorophenyl)pyridinato-N,$C^{2'}$]iridium(III)picolinate (FIrpic); bis{2-[3',5'-bis(trifluoromethyl)phenyl]pyridinato-N,$C^{2'}$}iridium(picolinate) (abbreviation: $Ir(CF_3\ ppy)_2(pic)$); tris(2-phenylpyridinato-N,$C^{2'}$)iridium (abbreviation: $Ir(ppy)_3$); bis(2-phenylpyridinato-N,$C^{2'}$)iridium(acetylacetonate) (abbreviation: $Ir(ppy)_2(acac)$); bis[2-(2'-thienyl)pyridinato-N,$C^{3'}$]iridium(acetylacetonate) (abbreviation: $Ir(thp)_2(acac)$); bis(2-phenylquinolinato-N,$C^{2'}$)iridium(acetylacetonate) (abbreviation: $Ir(pq)_2(acac)$); bis[2-(2'-benzothienyl)pyridinato-N,$C^{3'}$]iridium(acetylacetonate) (abbreviation: $Ir(btp)_2(acac)$); or the like.

Further alternatively, the light-emitting layer may be formed of an electroluminescent polymeric material such as a polyparaphenylene-vinylene-based material, a polyparaphenylene-based material, a polythiophene-based material, or a polyfluorene-based material.

In any case, the layer structure of the light-emitting layer may change, and modification is possible as long as a light-emitting element can be formed. For example, such a structure can be employed where no specific hole or electron injecting/transporting layer is provided, but instead, a substitute electrode layer for this purpose is provided or a light-emitting material is dispersed in the layer.

The other of the first electrode **2407** or the third electrode **2417** may be formed of a material which does not transmit light. For example, it may be formed of alkali metals such as Li and Cs, alkaline earth metals such as Mg, Ca, or Sr, alloys containing such metals (e.g., Mg:Ag, Al:Li, or Mg:In), compounds containing such metals (e.g., CaF_2 or CaN), or rare earth metals such as Yb or Er.

The third insulating film **2408** can be formed of a material similar to that of the second insulating film **2405**. The third insulating film **2408** is formed on the periphery of the second electrode **2407** so as to cover the edge of the second electrode **2407**, and has a function of separating the light-emitting layers **2409** of adjacent pixels.

The light-emitting layer **2409** is formed by a single layer or a plurality of layers. In the case where the light-emitting layer **2409** is formed by a plurality of layers, the layers can be classified into a hole injecting layer, a hole transporting layer, a light-emitting layer, an electron transporting layer, an electron injecting layer, and the like, in terms of the carrier transporting properties. Note that the boundary between the respective layers is not necessarily clear, and there may be a case where materials forming adjacent layers are partially mixed with each other, which makes the interface therebetween unclear. Each layer can be formed of an organic material or an inorganic material. The organic material may be any of high molecular, medium molecular, and low molecular materials.

The light-emitting element **2415** is formed to have the light-emitting layer **2409** and the second electrode **2407** and the third electrode **2417** which overlap each other with the light-emitting element **2409** sandwiched therebetween. One of the second electrode **2407** or the third electrode **2417** corresponds to an anode, while the other corresponds to a cathode. When forward-bias voltage which is higher than the threshold voltage is applied between the anode and the cathode of the light-emitting element **2415**, current flows from the anode to the cathode, and thus the light-emitting element **2415** emits light.

A structure of FIG. **24**B is described next. Note that common portions between FIGS. **24**A and **24**B are denoted by same reference numerals, and thus the description thereon will be omitted.

FIG. **24**B shows a structure where another insulating film **2418** is provided between the second insulating film **2405** and the third insulating film **2408** in FIG. **24**A. The second electrode **2416** and the first electrode **2406** are connected in a contact hole provided in the insulating film **2418**.

The insulating film **2418** can be formed to have a structure similar to that of the second insulating film **2405**. The second electrode **2416** can be formed to have a structure similar to that of the first electrode **2406**.

Embodiment 2

In this embodiment, description is made on a case where an amorphous silicon film is used as a semiconductor layer of a transistor. FIGS. **28**A and **28**B show top-gate transistors, while FIGS. **29**A to **30**B show bottom-gate transistors.

FIG. **28**A shows a cross section of a transistor with a top-gate structure, where amorphous silicon is used for a semiconductor layer. As shown in FIG. **28**A, a base film **2802** is formed over a substrate **2801**. Further, a pixel electrode **2803** is formed over the base film **2802**. In addition, a first electrode **2804** is formed of the same material and in the same layer as the pixel electrode **2803**.

The substrate may be a glass substrate, a quartz substrate, a ceramic substrate, or the like. In addition, the base film **2802** may be formed of aluminum nitride (AlN), silicon oxide, silicon oxynitride (SiO_xN_y), and the like, and is formed by either a single layer or stacked layers.

Further, wires **2805** and **2806** are formed over the base film **2802**, and the edge of the pixel electrode **2803** is covered with the wire **2805**. N-type semiconductor layers **2807** and **2808** each having n-type conductivity are formed over the wires **2805** and **2806**, respectively. In addition, a semiconductor layer **2809** is formed between the wires **2805** and **2806**, and over the base film **2802**. A part of the semiconductor layer **2809** is extended to cover the n-type semiconductor layers **2807** and **2808**. Note that the semiconductor layer is formed by an amorphous semiconductor film such as amorphous silicon (a-Si:H), a microcrystalline semiconductor (μ-Si:H), or the like. A gate insulating film **2810** is formed over the semiconductor layer **2809**. In addition, an insulating film **2811** is formed of the same material and in the same layer as the gate insulating film **2810**, over the first electrode **2804**. Note that the gate insulating film **2810** is formed by a silicon oxide film, a silicon nitride film, or the like.

A gate electrode **2812** is formed over the gate insulating film **2810**. In addition, a second electrode **2813** is formed of the same material and in the same layer as the gate electrode, over the first electrode **2804** with the insulating film **2811** sandwiched therebetween. Thus, a capacitor **2819** is formed, in which the insulating film **2811** is sandwiched between the first electrode **2804** and the second electrode **2813**. An interlayer insulating film **2814** is formed covering edges of the pixel electrode **2803**, a driving transistor **2818**, and the capacitor **2819**.

A layer **2815** containing an organic compound and a counter electrode **2816** are formed over the interlayer insulating film **2814** and the pixel electrode **2803** positioned in an opening of the interlayer insulating film **2814**. A light-emitting element **2817** is formed in a region where the layer **2815** containing an organic compound is sandwiched between the pixel electrode **2803** and the counter electrode **2816**.

The first electrode **2804** shown in FIG. **28**A may be replaced with a first electrode **2820** as shown in FIG. **28**B. The first electrode **2820** is formed of the same material and in the same layer as the wires **2805** and **2806**.

FIGS. **29**A and **29**B show partial cross-sectional views of a panel of a semiconductor device which has a bottom-gate transistor using amorphous silicon for its semiconductor layer.

A gate electrode **2903** is formed over a substrate **2901**. In addition, a first electrode **2904** is formed of the same material and in the same layer as the gate electrode **2903**. As a material of the gate electrode **2903**, polycrystalline silicon to which phosphorus is added can be used. Silicide which is a compound of a metal and silicon may be used as well as the polycrystalline silicon.

In addition, a gate insulating film **2905** is formed to cover the gate electrode **2903** and the first electrode **2904**. The gate insulating film **2905** is formed by a silicon oxide film, a silicon nitride film, or the like.

A semiconductor layer **2906** is formed over the gate insulating film **2905**. In addition, a semiconductor layer **2907** is formed of the same material and in the same layer as the semiconductor layer **2906**. The substrate may be any of a glass substrate, a quartz substrate, a ceramic substrate, and the like.

N-type semiconductor layers **2908** and **2909** each having n-type conductivity are formed over the semiconductor layer **2906**, while an n-type semiconductor layer **2910** is formed over the semiconductor layer **2907**.

Wires **2911** and **2912** are formed over the n-type semiconductor layers **2908** and **2909**, respectively, and a conductive layer **2913** is formed of the same material and in the same layer as the wires **2911** and **2912**, over the n-type semiconductor layer **2910**.

A second electrode is formed to have the semiconductor layer **2907**, the n-type semiconductor layer **2910**, and the conductive layer **2913**. Note that a capacitor **2920** is formed to have a structure where the gate insulating film **2905** is sandwiched between the second electrode and the first electrode **2904**.

In addition, the edge of the wire **2911** is extended, and a pixel electrode **2914** is formed to be in contact with the top surface of the extended portion of the wire **2911**.

An insulating layer **2915** is formed to cover a driving transistor **2919**, the capacitor **2920**, and the edge of the pixel electrode **2914**.

A layer **2916** containing an organic compound and a counter electrode **2917** are formed over the pixel electrode **2914** and the insulating layer **2915**. A light-emitting element **2918** is formed in a region where the layer **2916** containing an organic compound is sandwiched between the pixel electrode **2914** and the counter electrode **2917**.

The semiconductor layer **2907** and the n-type semiconductor layer **2910** which serve as a part of a second electrode of the capacitor are not necessarily provided. That is, only the conductive layer **2913** may be used as the second electrode so that a capacitor is provided to have a structure where a gate insulating film is sandwiched between the first electrode **2904** and the conductive layer **2913**.

Note that if the pixel electrode **2914** is formed before forming the wire **2911** shown in FIG. **29**A, a capacitor **2920** shown in FIG. **29**B can be formed, which has a structure where the gate insulating film **2905** is sandwiched between the first electrode **2904** and a second electrode **2921** formed by the pixel electrode **2914**.

Although FIGS. **29**A and **29**B show examples of an inversely staggered transistor with a channel-etched structure, a transistor with a channel-protected structure may be employed as well. Next, description is made on a transistor with a channel-protected structure, with reference to FIGS. **30**A and **30**B.

A transistor with a channel-protected structure shown in FIG. **30**A differs from the driving transistor **2919** with a channel-etched structure shown in FIG. **29**A in that an insulating layer **3001** serving as an etching mask is provided over a channel formation region in the semiconductor layer **2906**. Common portions between FIGS. **29**A and **30**A are denoted by the same reference numerals.

Similarly, a transistor with a channel-protected structure shown in FIG. **30**B differs from the driving transistor **2919** with a channel-etched structure shown in FIG. **29**B in that an insulating layer **3001** serving as an etching mask is provided over a channel formation region in the semiconductor layer **2906**. Common portions between FIGS. **29**B and **30**B are denoted by the same reference numerals.

By using an amorphous semiconductor film for a semiconductor layer (such as a channel forming region, a source region, or a drain region) in a transistor included in a pixel of the present invention, a manufacturing cost can be reduced. For example, an amorphous semiconductor film can be applied by employing the pixel structure shown in FIGS. **6** and **7**.

Note that the structures of transistors or capacitors to which the pixel structure of the present invention can be applied are not limited to the structures described above, and various structures of transistors or capacitors can be employed.

This embodiment can be conducted by freely combining with Embodiment 1.

Embodiment 3

In this embodiment, description is made on a method of manufacturing a display device using plasma treatment, as a method of manufacturing a display device including transistors, for example.

FIGS. **31**A to **31**C show an example of a structure of a semiconductor device including transistors. Note that FIG. **31**B corresponds to a cross-sectional view taken along a line a-b in FIG. **31**A, while FIG. **31**C corresponds to a cross-sectional view taken along a line c-d in FIG. **31**A.

The semiconductor device shown in FIGS. **31**A to **31**C includes semiconductor films **4603***a* and **4603***b* formed over a substrate **4601** with an insulating film **4602** sandwiched therebetween, a gate electrode **4605** formed over the semiconductor films **4603***a* and **4603***b* with a gate insulating layer **4604** sandwiched therebetween, insulating films **4606** and **4607** formed to cover the gate electrode, and a conductive film **4608** formed over the insulating film **4607** in a manner electrically connected to a source region or a drain region of the semiconductor films **4603***a* and **4603***b*. Although FIGS. **31**A to **31**C show a case of showing an n-channel transistor **4610***a* which uses a part of the semiconductor film **4603***a* as a channel region, and a p-channel transistor **4610***b* which uses a part of the semiconductor film **4603***b* as a channel region, the present invention is not limited to such a structure. For example, although the n-channel transistor **4610***a* is provided with LDD regions **4611**, while the p-channel transistor **4610***b* is not provided with LDD regions in FIGS. **31**A to **31**C, such structures may be employed in that both of the transistors are provided with LDD regions or neither of the transistors is provided with LDD regions.

In this embodiment, the semiconductor device shown in FIGS. **31**A to **31**C is manufactured by oxidizing or nitriding a semiconductor film or an insulating film, that is, by performing oxidation or nitridation by plasma treatment to at least one layer among the substrate **4601**, the insulating film **4602**, the semiconductor films **4603***a* and **4603***b*, the gate insulating film **4604**, the insulating film **4606**, and the insulating film **4607**. In this manner, by oxidizing or nitriding a semiconductor film or an insulating film by plasma treatment, the surface of the semiconductor film or the insulating film can be modified, thereby a dense insulating film can be formed compared with an insulating film formed by CVD or sputtering. Therefore, defects such as pin holes can be suppressed, and thus the characteristics and the like of the display device can be improved.

In this embodiment, description is made on a method of manufacturing a display device by oxidizing or nitriding the semiconductor films **4603***a* and **4603***b* or the gate insulating film **4604** shown in FIGS. **31**A to **31**C by plasma treatment, with reference to the drawings.

First, a case is shown where an island-shaped semiconductor film over a substrate is formed to have an edge with an angle of about 90°.

First, the semiconductor films **4603***a* and **4603***b* having island shapes are formed over the substrate **4601** (FIG. **32**A). The island-shaped semiconductor films **4603***a* and **4603***b* can be provided by forming an amorphous semiconductor film by sputtering, LPCVD, plasma CVD, or the like using a material containing silicon (Si) as a main component (e.g., SixGe1−x) over the insulating film **4602** which is formed in advance over the substrate **4601**, and then crystallizing the amorphous semiconductor film, and further etching the semiconductor film selectively. Note that the crystallization of the amorphous semiconductor film can be performed by a crystallization method such as laser crystallization, thermal crystallization using RTA or an annealing furnace, thermal crystallization using metal elements which promote crystallization, or a combination of them. Note that in FIGS. **32**A to **32**D, the island-shaped semiconductor films **4603***a* and **4603***b* are each formed to have an edge with an angle of about 90° (θ=85 to 100°).

Next, the semiconductor films **4603***a* and **4603***b* are oxidized or nitrided by plasma treatment to form oxide or nitride films **4621***a* and **4621***b* (hereinafter also called insulating films **4621***a* and **4621***b*) on the surfaces of the semiconductor films **4603***a* and **4603***b*, respectively (FIG. **32**B). For example, when Si is used for the semiconductor films **4603***a* and **4603***b*, silicon oxide or silicon nitride is formed as the insulating films **4621***a* and **4621***b*. Further, after being oxidized by plasma treatment, the semiconductor films **4603***a* and **4603***b* may be treated with plasma again to be nitrided. In this case, silicon oxide is formed on the semiconductor films **4603***a* and **4604***b*, and then silicon nitride oxide (SiN_xO_y, x>y) is formed on the surface of the silicon oxide. Note that in the case of oxidizing the semiconductor film by plasma treatment, the plasma treatment is performed under an oxygen atmosphere (e.g., an atmosphere containing oxygen (O_2) and a rare gas (at least one of He, Ne, Ar, Kr, and Xe), an atmosphere containing oxygen, hydrogen (H_2), and a rare gas, or an atmosphere containing nitrous oxide and a rare gas). Meanwhile, in the case of nitriding the semiconductor film by plasma treatment, the plasma treatment is performed under a nitrogen atmosphere (e.g., an atmosphere containing nitrogen (N_2) and a rare gas (at least one of He, Ne, Ar, Kr, and Xe), an atmosphere containing nitrogen, hydrogen, and a rare gas, or an atmosphere containing NH_3 and a rare gas). As the rare gas for example, Ar can be used. Alternatively, a mixed gas of Ar and Kr may be used. Therefore, the insulating films **4621**a and **4621**b contain the rare gas (at least one of He, Ne, Ar, Kr, and Xe) used in the plasma treatment. In the case where Ar is used, the insulating films **4621**a and **4621**b contain Ar.

The plasma treatment is performed in the atmosphere containing the foregoing gas, with the conditions of an electron density of 1×10^{11} to 1×10^{13} cm^{-3}, and a plasma electron temperature of 0.5 to 1.5 eV. Since the plasma electron density is high and the electron temperature in the vicinity of the subject to be treated (here, the semiconductor films **4603**a and **4603**b) formed over the substrate **4601** is low, plasma damage to the subject to be treated can be prevented. In addition, since the plasma electron density is as high as 1×10^{11} cm^{-3} or more, an oxide or nitride film formed by oxidizing or nitriding the subject to be treated by plasma treatment is advantageous in its uniform thickness or the like as well as being dense compared with a film formed by CVD, sputtering, or the like. Further, since the plasma electron temperature is as low as 1 eV, oxidation or nitridation treatment can be performed at a low temperature compared with the conventional plasma treatment or thermal oxidation. For example, oxidation or nitridation treatment can be performed sufficiently even when plasma treatment is performed at a temperature lower than the strain point of a glass substrate by 100 degrees or more. Note that as a frequency for generating plasma, high frequencies such as microwaves (2.45 GHz) can be used. Note also that the plasma treatment is to be performed with the foregoing conditions unless otherwise specified.

Next, the gate insulating film **4604** is formed so as to cover the insulating films **4621**a and **4621**b (FIG. **32**C). The gate insulating film **4604** can be formed by an insulating film containing oxygen or nitrogen, such as silicon oxide, silicon nitride, silicon oxynitride (SiO_xN_y, x>y), or silicon nitride oxide (SiN_xO_y, x>y) by sputtering, LPCVD, plasma CVD, or the like to have either a single-layer structure or a stacked layer structure. For example, when Si is used for the semiconductor films **4603**a and **4603**b, and the Si is oxidized by plasma treatment to form silicon oxide as the insulating films **4621**a and **4621**b on the surfaces of the semiconductor films **4603**a and **4603**b, silicon oxide is formed as a gate insulating film over the insulating films **4621**a and **4621**b. In addition, in FIG. **32**B, if the insulating films **4621**a and **4621**b formed by oxidizing or nitriding the semiconductor films **4603**a and **4603**b by plasma treatment are sufficiently thick to form gate insulating films, the insulating films **4621**a and **4621**b can be used as the gate insulating films.

Next, by forming the gate electrodes **4605** or the like over the gate insulating film **4604**, a display device having the n-channel transistor **4610**a and the p-channel transistor **4610**b which respectively have the island-shaped semiconductor films **4603**a and **4603**b as channel regions can be manufactured (FIG. **32**D).

In this manner, by oxidizing or nitriding the surfaces of the semiconductor films **4603**a and **4603**b by plasma treatment before providing the gate insulating film **4604** over the semiconductor films **4603**a and **4603**b, short circuits or the like between the gate electrodes and the semiconductor films can be prevented, which would otherwise be caused by coverage defects of the gate insulating film **4604** at edges **4651**a and **4651**b of the channel regions. That is, if the edges of the island-shaped semiconductor films have an angle of about 90° (θ=85 to 100°), there may be a problem in that at the time when a gate insulating film is formed so as to cover the semiconductor films by CVD, sputtering, or the like, a coverage defect might be caused, resulting from breaking of the gate insulating film at the edges of the semiconductor films, or the like. However, such a coverage defect or the like can be prevented by oxidizing or nitriding the surfaces of the semiconductor films by plasma treatment in advance.

Alternatively, in FIGS. **32**A to **32**D, the gate insulating film **4604** may be formed and then, oxidized or nitrided by performing plasma treatment. In this case, an oxide or nitride film (hereinafter also referred to as an insulating film **4623**) is formed on the surface of the gate insulating film **4604** (FIG. **33**B) by oxidizing or nitriding the gate insulating film **4604** by performing plasma treatment to the gate insulating film **4604** which is formed to cover the semiconductor films **4603**a and **4603**b (FIG. **33**A). The plasma treatment can be performed with conditions similar to those in FIG. **32**B. In addition, the insulating film **4623** contains the rare gas which is used in the plasma treatment. For example, in the case where Ar is used, the insulating film **4623** contains Ar.

Alternatively, in FIG. **33**B, after oxidizing the gate insulating film **4604** by performing plasma treatment under an oxygen atmosphere, the gate insulating film **4604** may be treated with plasma again under a nitrogen atmosphere so as to be nitrided. In this case, silicon oxide or silicon oxynitride (SiO_xN_y, x>y) is formed on the semiconductor films **4603**a and **4603**b side, and silicon nitride oxide (SiN_xO_y, x>y) is formed so as to be in contact with the gate electrodes **4605**. After that, by forming the gate electrodes **4605** or the like over the insulating film **4623**, a display device having the n-channel transistor **4610**a and the p-channel transistor **4610**b which respectively have the island-shaped semiconductor films **4603**a and **4603**b as channel regions can be manufactured (FIG. **33**C). In this manner, by oxidizing or nitriding the surface of the gate insulating film by plasma treatment, the surface of the gate insulating film can be modified to form a dense film. The insulating film obtained by the plasma treatment is dense and has few defects such as pin holes compared with an insulating film formed by CVD or sputtering. Therefore, the characteristics of the transistors can be improved.

Although FIGS. **33**A to **33**C show the case where the surfaces of the semiconductor films **4603**a and **4603**b are oxidized or nitrided by performing plasma treatment to the semiconductor films **4603**a and **4603**b in advance, such a method may be employed in which plasma treatment is not performed to the semiconductor films **4603**a and **4603**b, but is performed after forming the gate insulating film **4604**. In this manner, by performing plasma treatment before forming a gate electrode, a semiconductor film can be oxidized or nitrided even if the semiconductor film is exposed due to a coverage defect such as breaking of a gate insulating film at edges of the semiconductor film; therefore, short circuits or the like between the gate electrode and the semiconductor film can be prevented, which would otherwise be caused by a coverage defect of the gate insulating film at the edges of the semiconductor film.

In this manner, by oxidizing or nitriding the semiconductor films or the gate insulating film by plasma treatment, short circuits or the like between the gate electrodes and the semiconductor films can be prevented, which would otherwise be caused by a coverage defect of the gate insulating film at the edges of the semiconductor films, even if the island-shaped semiconductor films are formed to have edges with an angle of about 90°.

Next, a case is shown where the island-shaped semiconductor films formed over the substrate are formed to have tapered edges (θ=30 to 85°).

First, the semiconductor films **4603**a and **4603**b having island shapes are formed over the substrate **4601** (FIG. **34**A). The island-shaped semiconductor films **4603**a and **4603**b can be provided by forming an amorphous semiconductor film by sputtering, LPCVD, plasma CVD, or the like using a material containing silicon (Si) as a main component (e.g., SixGe1−x) over the insulating film **4602** which is formed in advance over the substrate **4601**, and then crystallizing the amorphous semiconductor film, and further etching the semiconductor film selectively. Note that the crystallization of the amorphous semiconductor film can be performed by a crystallization method such as laser crystallization, thermal crystallization using RTA or an annealing furnace, thermal crystallization using metal elements which promote crystallization, or a combination of them. Note that in FIGS. **34**A to **34**D, the island-shaped semiconductor films are each formed to have a tapered edge (θ=30 to 85°).

Next, the gate insulating film **4604** is formed so as to cover the insulating films **4603***a* and **4603***b* (FIG. **34**B). The gate insulating film **4604** can be formed by an insulating film containing oxygen or nitrogen, such as silicon oxide, silicon nitride, silicon oxynitride (SiO_xN_y, x>y), or silicon nitride oxide (SiN_xO_y, x>y) by sputtering, LPCVD, plasma CVD, or the like to have either a single-layer structure or a stacked layer structure.

Next, an oxide or nitride film (hereinafter also referred to as an insulating film **4624**) is formed on the surface of the gate insulating film **4604** by oxidizing or nitriding the gate insulating film **4604** by plasma treatment (FIG. **34**C). The plasma treatment can be performed with the conditions similar to those described above. For example, if silicon oxide or silicon oxynitride (SiO_xN_y, x>y) is used as the gate insulating film **4604**, the gate insulating film **4604** is oxidized by performing plasma treatment under an oxygen atmosphere, thereby a dense film can be formed on the surface of the gate insulating film with few defects such as pin holes compared with a gate insulating film formed by CVD, sputtering, or the like. On the other hand, if the gate insulating film **4604** is nitrided by plasma treatment under a nitrogen atmosphere, a silicon nitride oxide film (SiN_xO_y, x>y) can be provided as the insulating film **4624** on the surface of the gate insulating film **4604**. Alternatively, after oxidizing the gate insulating film **4604** by performing plasma treatment under an oxygen atmosphere, the gate insulating film **4604** may be treated with plasma again under a nitrogen atmosphere so as to be nitrided. In addition, the insulating film **4624** contains the rare gas which is used in the plasma treatment. For example, in the case where Ar is used, the insulating film **4624** contains Ar.

Next, by forming the gate electrodes **4605** or the like over the gate insulating film **4604**, a display device having the n-channel transistor **4610***a* and the p-channel transistor **4610***b* which respectively have the island-shaped semiconductor films **4603***a* and **4603***b* as channel regions can be manufactured (FIG. **34**D).

In this manner, by performing plasma treatment to the gate insulating film, an insulating film formed of an oxide or nitride film can be provided on the surface of the gate insulating film, and thus the surface of the gate insulating film can be modified. Since the insulating film obtained by oxidation or nitridation with plasma treatment is dense and has few defects such as pin holes, compared with a gate insulating film formed by CVD or sputtering, the characteristics of the transistors can be improved. In addition, whereas short circuits or the like between the gate electrode and the semiconductor films can be prevented by forming the semiconductor films to have tapered edges, which would otherwise be caused by a coverage defect of the gate insulating film at the edges of the semiconductor films, short circuits or the like between the gate electrode and the semiconductor films can be prevented even more effectively by performing plasma treatment after forming the gate insulating film.

Next, description is made on a manufacturing method of a display device which differs from that in FIGS. **34**A to **34** C with reference to the drawings. Specifically, a case is shown where plasma treatment is selectively performed to tapered edges of semiconductor films.

First, the island-shaped semiconductor films **4603***a* and **4603***b* are formed over the substrate **4601** (FIG. **35**A). The island-shaped semiconductor films **4603***a* and **4603***b* can be provided by forming an amorphous semiconductor film using a material containing silicon (Si) as a main component (e.g., Si_xGe_{1-x}) or the like over the insulating film **4602** which is formed over the substrate **4601** in advance, by sputtering, LPCVD, plasma CVD, or the like, and crystallizing the amorphous semiconductor film, and further etching the semiconductor film selectively by using resists **4625***a* and **4625***b* as masks. Note that the crystallization of the amorphous semiconductor film can be performed by laser crystallization, thermal crystallization using RTA or an annealing furnace, thermal crystallization using metal elements which promote crystallization, or a combination of them.

Next, the edges of the island-shaped semiconductor films **4603***a* and **4603***b* are selectively oxidized or nitrided by plasma treatment before removing the resists **4625***a* and **4625***b* which are used for etching the semiconductor films, thereby an oxide or nitride film (hereinafter also referred to as an insulating film **4626**) is formed on each of the semiconductor films **4603***a* and **4603***b* (FIG. **35**B). The plasma treatment is performed with the foregoing conditions. In addition, the insulating film **4626** contains the rare gas which is used in the plasma treatment.

Next, the gate insulating film **4604** is formed so as to cover the semiconductor films **4603***a* and **4603***b* (FIG. **35**C). The gate insulating film **4604** can be formed as described above.

Next, by forming the gate electrodes **4605** or the like over the gate insulating film **4604**, a display device having the n-channel transistor **4610***a* and the p-channel transistor **4610***b* which respectively have the island-shaped semiconductor films **4603***a* and **4603***b* as channel regions can be manufactured (FIG. **35**D).

If the semiconductor films **4603***a* and **4603***b* are provided with tapered edges, edges **4652***a* and **4652***b* of the channel regions which are formed in parts of the semiconductor films **4603***a* and **4603***b* are also tapered, thereby the thickness of the semiconductor films and the gate insulating film in that part differs from that in the central part, which may affect the characteristics of the transistors. Here, such effects on the transistors due to the edges of the channel regions can be reduced by forming insulating films on the edges of the semiconductor films which are the edges of the channel regions, by selectively oxidizing or nitriding the edges of the channel regions by plasma treatment.

Although FIGS. **35**A to **35**D show an example where only the edges of the semiconductor films **4603***a* and **4603***b* are oxidized or nitrided by plasma treatment, the gate insulating film **4604** can also be oxidized or nitrided by plasma treatment as shown in FIGS. **34**A to **34**D (FIG. **37**A).

Next, description is made on a manufacturing method of a semiconductor device which differs from that described above, with reference to the drawings. Specifically, a case is shown where plasma treatment is performed to tapered semiconductor films.

First, the island-shaped semiconductor films **4603***a* and **4603***b* are formed over the substrate **4601** in a manner similar to the foregoing (FIG. **36**A).

Next, the semiconductor films **4603***a* and **4603***b* are oxidized or nitrided by plasma treatment to form oxide or nitride films (hereinafter also called insulating films **4627***a* and

4627*b*) on the surfaces of the semiconductor films **4603***a* and **4603***b*, respectively (FIG. **36**B). The plasma treatment can be conducted under the above described conditions. For example, when Si is used for the semiconductor films **4603***a* and **4603***b*, silicon oxide or silicon nitride is formed as the insulating films **4627***a* and **4627***b*. Further, after being oxidized by plasma treatment, the semiconductor films **4603***a* and **4603***b* may be treated with plasma again to be nitrided. In this case, silicon oxide silicon oxynitride (SiO_xN_y, x>y), is formed on the semiconductor films **4603***a* and **4604***b*, and then silicon nitride oxide (SiN_xO_y, x>y) is formed on the surface of the silicon oxide. Therefore, the insulating films **4627***a* and **4627***b* contain the rare gas used in the plasma treatment. Note that the plasma treatment also oxide or nitride the edges of the semiconductor films **4603***a* and **4603***b* simultaneously.

Next, the gate insulating film **4604** is formed so as to cover the insulating films **4627***a* and **4627***b* (FIG. **36**C). The gate insulating film **4604** can be formed by an insulating film containing oxygen or nitrogen, such as silicon oxide, silicon nitride, silicon oxynitride (SiO_xN_y, x>y), or silicon nitride oxide (SiN_xO_y, x>y) by sputtering, LPCVD, plasma CVD, or the like to have either a single-layer structure or a stacked layer structure. For example, when insulating films **4627***a* and **4627***b* are formed of silicon oxide over the semiconductor films **4603***a* and **4603***b* by oxidizing the semiconductor films **4603***a* and **4603***b* by plasma treatment using Si, silicon oxide is formed as the gate insulating film over the insulating films **4627***a* and **4627***b*.

Next, by forming the gate electrodes **4605** or the like over the gate insulating film **4604**, a display device having the n-channel transistor **4610***a* and the p-channel transistor **4610***b* which respectively have the island-shaped semiconductor films **4603***a* and **4603***b* as channel regions can be manufactured (FIG. **36**D).

If the semiconductor films are provided with tapered edges, edges of the channel regions which are formed in parts of the semiconductor films are also tapered, which may affect the characteristics of the semiconductor element. Such effects on the semiconductor element can be reduced by oxidizing or nitriding the edges of the semiconductor films which are the channel regions by plasma treatment to oxidize or nitride the edges of the channel regions.

Although FIGS. **36**A to **36**D show an example where only the semiconductor films **4603***a* and **4603***b* are oxidized or nitrided by plasma treatment, the gate insulating film **4604** may also be oxidized or nitrided by plasma treatment as shown in FIG. **34** (FIG. **37**B). In this case, after oxidizing the gate insulating film **4604** by performing plasma treatment under an oxygen atmosphere, the gate insulating film **4604** may be treated with plasma again under a nitrogen atmosphere so as to be nitrided. In such a case, silicon oxide or silicon oxynitride (SiO_xN_y, x>y) is formed over the semiconductor films **4603***a* and **4603***b* side, and then silicon nitride oxide (SiN_xO_y, x>y) is formed so as to be in contact with the gate electrodes **4605**.

By performing plasma treatment in the foregoing manner, impurities such as dust which have attached to the semiconductor films or the insulating film can be easily removed. In general, a film formed by CVD, sputtering, or the like may have dust (also called particles) on its surface. For example, as shown in FIG. **38**A, there is a case where dust **4673** attaches to the insulating film **4672** which is formed by CVD, sputtering, or the like over a film **4671** such as an insulating film, a conductive film, or a semiconductor film. Even in such a case, an oxide or nitride film (hereinafter also referred to as an insulating film **4674**) is formed on the surface of the insulating film **4672** by oxidizing or nitriding the insulating film **4672** by plasma treatment. The insulating film **4674** is oxidized or nitrided in such a manner that not only a portion where no dust **4673** exists but also a portion below the dust **4673** is oxidized or nitrided; therefore, the volume of the insulating film **4674** is increased. Meanwhile, since the surface of the dust **4673** is also oxidized or nitrided by plasma treatment to form an insulating film **4675**, the volume of the dust **4673** is also increased (FIG. **38**B).

At this time, the dust **4673** is in a state of being easily removed from the surface of the insulating film **4674** by simple washing such as brushing. Thus, by performing plasma treatment, even a minute dust which has attached to the insulating film or the semiconductor film can be easily removed. Note that this effect is obtained by performing plasma treatment; therefore, the same can be said for not only this embodiment mode, but for other embodiment modes.

In this manner, by modifying the surface of a semiconductor film or an insulating film by oxidation or nitridation using plasma treatment, a dense and high-quality insulating film can be formed. In addition, dust or the like which has attached to the surface of the insulating film can be easily removed by washing. Accordingly, defects such as pin holes can be prevented even when the insulating film is formed to be thin, thereby miniaturization and high performance of semiconductor elements such as transistors can be realized.

Although this embodiment shows an example where plasma treatment is performed to the semiconductor films **4603***a* and **4603***b* or the gate insulating film **4604** so as to oxidize or nitride the semiconductor films **4603***a* and **4603***b* or the gate insulating film **4604**, a layer to be oxidized or nitrided by plasma is not limited to these. For example, plasma treatment may be performed to the substrate **4601** or the insulating film **4602**. Alternatively, plasma treatment may be performed to the insulating film **4606** or the insulating film **4607**.

This embodiment can be conducted by freely combining with Embodiments 1 or **2**.

Embodiment 4

In this embodiment, description is made on a halftone process as a process for manufacturing a display device including, for example, transistors.

FIG. **39** shows a cross-sectional structure of a display device including a transistor, a capacitor, and a resistor. FIG. **39** shows an n-channel transistor **5401**, an n-channel transistor **5402**, a capacitor **5404**, a resistor **5405**, and a p-channel transistor **5403**. Each transistor includes a semiconductor layer **5505**, an insulating layer **5508**, and a gate electrode **5509**. The gate electrode **5509** is formed by a stacked layer structure of a first conductive layer **5503** and a second conductive layer **5502**. The insulating layer **5508** sandwiched between the semiconductor layer **5505** and the gate electrode **5509** serves as a gate insulating layer. FIGS. **40**A to **40**E are top views corresponding to the transistors, the capacitor, and the resistor, which can be referred together with FIG. **39**.

In FIG. **39**, the n-channel transistor **5401** has the semiconductor layer **5505** in the channel length direction (the flowing direction of carriers) that includes impurity regions **5506** and **5507** which is doped at a lower concentration than that of the impurity region **5506**. The impurity region **5506** serves as a source or a drain region and is connected to a wire **5504** electrically. The impurity region **5507** is also called a lightly doped drain (LDD). In the case of forming the n-channel transistor **5401**, the impurity regions **5506** and **5507** are doped with an impurity imparting n-type conductivity such as phosphorus. The LDD is formed so as to prevent hot electron deterioration and a short channel effect.

As shown in FIG. **40**A, in the gate electrode **5509** of the n-channel transistor **5401**, the first conductive layer **5503** is formed so as to extend to both sides of the second conductive layer **5502**. In that case, the thickness of the first conductive layer **5503** is thinner than that of the second conductive layer. The thickness of the first conductive layer **5503** is set so as to transmit ion species accelerated in an electric filed of 10 to 100 kV The impurity region **5507** is formed so as to overlap the first conductive layer **5503** of the gate electrode **5509**. That is, an LDD region which overlaps the gate electrode **5509** is formed. In this structure, the impurity region **5507** is formed in a self alignment manner by adding an impurity imparting one conductivity type through the first conductive layer **5503** using the second conductive layer **5502** as a mask. That is, the LDD which overlaps the gate electrode is formed in a self alignment manner.

In FIG. **39**, the n-channel transistor **5402** has the semiconductor layer **5505** that includes the impurity region **5506** serving as source and drain regions and the impurity region **5507** which is doped at a lower concentration than that of the impurity regions **5506**. The impurity region **5507** is formed on one side of the channel formation region so as to be in contact with the impurity region **5506**. As shown in FIG. **40**B, in the gate electrode **5509** of the n-channel transistor **5402**, the first conductive layer **5503** is formed so as to extend on one side of the second conductive layer **5502**. In such a structure also, the LDD can be formed in a self alignment manner by adding an impurity imparting one conductivity type through the first conductive layer **5503** using the second conductive layer **5502** as a mask.

A transistor having an LDD on one side of the channel formation region may be used as a transistor in which either a positive voltage or a negative voltage is applied between source and drain electrodes. Specifically, the transistor may be applied to a transistor forming a logical gate such as an inverter circuit, a NAND circuit, a NOR circuit, and a latch circuit, a transistor forming an analog circuit such as a sense amplifier, a constant voltage generating circuit, and a VCO.

As shown in FIG. **39**, the capacitor **5404** is formed so that the insulating layer **5508** is interposed between a first conductive layer **5503** and the semiconductor layer **5505**. The semiconductor layer **5505** in the capacitor **5404** has the impurity regions **5510** and **5511**. The impurity region **5511** is formed in the semiconductor layer **5505** so as to overlap the first conductive layer **5503**. The impurity region **5510** is in contact with the wire **5504**. Since the impurity region **5511** is doped with an impurity of one conductivity type through the first conductive layer **5503**, the concentrations of the impurities contained in the impurity regions **5510** and **5511** may be the same or different. In any case, in the capacitor **5404**, the semiconductor layer **5505** serves as an electrode; therefore the semiconductor layer **5505** is preferably doped with an impurity imparting one conductivity type to lower the resistance thereof. In addition, as shown in FIG. **40**C, the first conductive layer **5503** can sufficiently operate as an electrode by using the second conductive layer **5502** as an auxiliary electrode. Thus, the capacitor **5404** can be formed in a self alignment manner by combining the first conductive layer **5503** and the second conductive layer **5502** to form a multiple electrode structure.

In FIG. **39**, the resistor **5405** is formed using the first conductive layer **5503**. The first conductive layer **5503** is formed so as to have a thickness of 30 to 150 nm, therefore the width or the length of the first conductive layer **5503** can be appropriately set to form the resistor.

The resistor may be formed by a semiconductor layer containing an impurity element at a high concentration or a metal layer with a thin thickness. A metal layer is preferable to a semiconductor layer because the resistance value of the metal layer depends on a film thickness and a film quality while the resistance value of the semiconductor layer depends of a film thickness, a film quality, a concentration of an impurity, an activation ratio, and the like; therefore, variation in the resistance value of the metal layer is smaller than that of the semiconductor layer. FIG. **40**E shows a top view of the resistor **5405**.

In FIG. **39**, the p-channel transistor **5403** has an impurity region **5512** in the semiconductor layer **5505**. The impurity region **5512** forms source and drain regions each of which is connected to the wire **5504**. The gate electrode **5509** has a structure in which the first conductive layer **5503** and the second conductive layer **5502** overlap each other. The p-channel transistor **5403** is a transistor having a single drain structure in which an LDD is not formed. When the p-channel transistor **5403** is formed, the impurity region **5512** is doped with an impurity for imparting p-type conductivity, such as boron. On the other hand, when the impurity region **5512** is doped with phosphorus, an n-channel transistor having a single drain structure can be formed. FIG. **40**E shows a top view of the p-channel transistor **5403**.

To either or both the semiconductor layer **5505** and the insulating layer **5508**, oxidizing or nitriding treatment may be conducted using high-density plasma which is excited with a microwave and with an electron temperature of 2 eV or less, ion energy of 5 eV or less, and an electron density of approximately 10^{11} to 10^{13}/cm^{-3}. At this time, the treatment is conducted with a substrate temperature of 300 to 450° C. and in an oxidizing atmosphere (e.g., O_2, or N_2O) or a nitriding atmosphere (e.g., N_2, or NH_3); thereby a defect level of an interface between the semiconductor layer **5505** and the insulating layer **5508** can be lowered. In addition, by conducting the treatment to the insulating layer **5508**, the insulating layer **5508** can be denser. In other words, generation of a charged defect and change in a threshold voltage of a transistor can be suppressed. In a case where the transistor is driven at a voltage of 3 V or less, the insulating layer **5508** which is oxidized or nitrided by this plasma treatment can be used as a gate insulating layer. In a case where a transistor is driven at a voltage of 3 V or more, the insulating layer **5508** can be formed by combing the insulating layer which is formed on a surface of the semiconductor layer **5505** by this plasma treatment and the insulating layer which is stacked by CVD (plasma CVD or thermal CVD). In a similar manner, this insulating layer can be utilized as a dielectric layer of the capacitor **5404**. In this case, the insulating layer formed by this plasma treatment has a thickness of 1 to 10 nm and is a dense film; therefore, a capacitor having a large charge capacitance can be formed.

As described with reference to FIGS. **39** and **40**A to **40**E, an element with various kinds of structures can be formed by combing conductive layers having different film thicknesses. A region in which only the first conductive layer is formed and a region in which the first and the second conductive layers are stacked can be formed by using a photomask or a reticle which is formed by a diffraction grating pattern or an auxiliary pattern which has a semi-transparent film with a function of reducing light intensity. That is, in a photolithography process, when a photoresist is exposed to light, the amount of light which transmits through a photomask is adjusted so that a developed resist mask has a varied thickness. In this case, a slit which is equal to or below the resolution limitation may be formed in the photomask or the reticle so that a resist having the foregoing complicated shape is formed. In addition, a mask pattern formed of a photoresist material may be changed in the shape by being baked at about 200° C. after development.

In addition, by using a photomask or a reticle which is formed by a diffraction grating pattern or an auxiliary pattern which has a semi-transparent film with a function of reducing light intensity, the region where only the first conductive layer is formed and the region where the first conductive layer and the second conductive layer are stacked can be continuously formed. As shown in FIG. **40**A, a region in which only the first conductive layer is formed can be selectively formed over the semiconductor layer. Such a region is effective over the semiconductor layer but is not necessary in other regions (a wire region connected to the gate electrode). By using the photomask or the reticle, a region in which only the first conducive layer is formed is not formed in a wire part; therefore, wire density can be substantially increased.

In FIGS. **39** and **40**A to **40**E, the first conductive layer is formed of a high melting point metal such as tungsten (W), chromium (Cr), tantalum (Ta), tantalum nitride (TaN), or molybdenum (Mo); or an alloy or a compound mainly containing a high melting point metal to have a thickness of 30 to 50 nm. The second conductive layer is formed of a high melting point metal such as tungsten (W), chromium (Cr), tantalum (Ta), tantalum nitride (TaN), or molybdenum (Mo); or an alloy or a compound mainly containing a high melting point metal to have a thickness of 300 to 600 nm. For example, the first conductive layer and the second conductive layer are formed of different conductive materials so that the etching rates are different from each other in a next etching step. For example, the first conductive layer can be formed of TaN and the second conductive layer formed of a tungsten film.

In this embodiment, a transistor, a capacitor, and a resistor, each of which has a different electrode structure can be formed in one patterning step by using a photomask or a reticle which is formed by a diffraction grating pattern or an auxiliary pattern which has a semi-transparent film with a function of reducing light intensity. Thus, elements with different structures can be formed without increasing the number of steps and can be integrated according to the characteristics of the circuit.

This embodiment can be conducted by freely combining with Embodiments 1 to 3.

Embodiment 5

In this embodiment, description is made on an example of a mask pattern for manufacturing a display device including a transistor with reference to FIGS. **41**A to **43**B.

Semiconductor layers **5610** and **5611** shown in FIG. **41**A are preferably formed of silicon or a crystalline semiconductor containing silicon. For example, polycrystalline silicon or single crystalline silicon which is formed by crystallizing a silicon film by laser annealing or the like is applied. In addition, a metal oxide semiconductor, amorphous silicon, or an organic semiconductor which shows semiconductor characteristics can be applied.

In any case, a semiconductor layer which is formed first is formed over the entire surface or a part (a region which is larger than a region which is specified to be a semiconductor region in a transistor) of a substrate having an insulating surface. Then, a mask pattern is formed over the semiconductor layer by photolithography. The semiconductor layer is etched using the mask pattern to form the predetermined island-shaped semiconductor layers **5610** and **5611** including source and drain regions and a channel formation region of a transistor. The semiconductor layers **5610** and **5611** are formed so as to have an appropriate layout.

The photomask for forming the semiconductor layers **5610** and **5611** shown in FIG. **41**A has a mask pattern **5630** shown in FIG. **41**B. The mask pattern **5630** differs depending on whether a resist used in a photolithography step is a positive type or a negative type. When a positive type resist is used, the mask pattern **5630** shown in FIG. **41**B is formed as a light shielding portion. The mask pattern **5630** has a polygon shape in which a top A is removed. In addition, in a corner portion B, the mask pattern bends a plurality of times so as not to make a right angle. That is, in this photomask pattern, a corner that is a right triangle is removed so that one side of the right triangle is, for example, 10 μm or less.

The shape of the mask pattern **5630** shown in FIG. **41**B is reflected in the semiconductor layers **5610** and **5611** shown in FIG. **41**A. In that case, the shape which is similar to the mask pattern **5630** may be transcribed. Alternatively, the shape may be transcribed so that the corner of the transcribed pattern has a rounder shape than the mask pattern **5630**. That is, a round portion where the pattern shape is smoother than the mask pattern **5630** may be provided.

An insulating layer including silicon oxide or silicon nitride in at least one portion thereof is formed over the semiconductor layers **5610** and **5611**. The insulating layer is formed so as to serve as a gate insulating layer. As shown in FIG. **42**A, gate wires **5712**, **5713**, and **5714** are formed to overlap the semiconductor layer partially. The gate wire **5712** is formed corresponding to the semiconductor layer **5610** while the gate wire **5713** is formed corresponding to the semiconductor layers **5610** and **5611**. In addition, the gate wire **5714** is formed corresponding to the semiconductor layers **5610** and **5611**. The gate wire is formed by forming a metal layer or a semiconductor layer having high conductivity, and a shape of the gate wire is formed by photolithography over the insulating layer.

A photomask used for forming the gate wire has a mask pattern **5731** shown in FIG. **42**B. In the mask pattern **5731**, each corner portion bent into an L shape is removed so that one side of the right triangle is 10 μm or less, or one-fifth to half the width of the wire, thereby the corner portion is rounded. The shape of the mask pattern **5731** shown in FIG. **42**B is reflected to the gate wires **5712**, **5713**, and **5714** shown in FIG. **42**A. In that case, the shape which is similar to the mask pattern **5731** may be transcribed. Alternatively, the shape may be transcribed so that the corners in the gate wires **5712** to **5714** have rounder shapes than the mask pattern **5731**. That is, a round part where the pattern shape is smoother than the mask pattern **5731** may be provided. In other word, the corner in the gate wires **5712** to **5714** is removed by one-fifth to half the width of the wire in order to have a round corner portion. Specifically, in order to form a round circumference of the corner portion, a portion of the mask is removed, which corresponds to an isosceles right triangle having two first straight lines that are perpendicular to each other making the corner portion, and a second straight line that makes an angle of about 45° with the two first straight lines. When removing the triangle, two obtuse angles are formed in the mask. It is preferable that the mask be set so that a curved line in contact with the first straight line and the second straight line is formed in each obtuse angle part by adjusting conditions appropriately. Note that the length of the two sides of the isosceles right triangle, which are equal to each other, is equal to or longer than one-fifth the width of the mask and equal to or shorter than half the width of the mask. In addition, the inner circumference of the corner portion is also made round in accordance with the outer circumference of the corner portion. In an outer side of the corner portion, generation of fine powder due to abnormal electrical discharge can be suppressed when dry etching by plasma is conducted. In addition, even if fine powder is generated, an inner side of the corner portion makes it possible to wash away the fine powder when cleaning without the fine powder remaining in the corner. As a result, a yield improves significantly.

An interlayer insulating layer is formed after forming the gate wires **5712** to **5714**. The interlayer insulating layer is formed of an inorganic insulating material such as silicon oxide or an organic insulating material such as polyimide or an acryl resin. An insulating layer such as silicon nitride or silicon nitride oxide may be formed between the interlayer insulating layer and the gate wires **5712** to **5714**. In addition, an insulating layer such as silicon nitride or silicon nitride oxide may also be formed over the interlayer insulating layer. The insulating layer can prevent contamination of the semiconductor layer and the gate insulating layer due to an impurity which is not favorable to a transistor, such as exogenous metal ion and moisture.

In the interlayer insulating layer, an opening is formed in a predetermined position. For example, the opening is formed corresponding to the gate wire or the semiconductor layer placed blow. A wire layer formed of a single layer or a plurality of layers of metal or a metal compound is etched into a predetermined pattern with a mask pattern formed by photolithography. Then, as shown in FIG. **43**A, wires **5815** to **5820** are formed to overlap the semiconductor layer partially. The wire connects specific elements. The wire connecting an element to another element is not straight but bent due to restriction of a layout. In addition, the width of the wire changes in a contact portion or another region. In the contact portion, the width of the wire is widened in a part of the contact portion where the contact hole is equal to or wider than the width of the wire.

A photomask for forming the wires **5815** to **5820** has a mask pattern **5832** shown in FIG. **43**B. In this case, the wire also has a pattern where a corner that is a right triangle in each corner portion is removed so that one side of the right triangle is 10 μm or shorter, or one-fifth to half the width of the wire; thereby the corner portion is rounded. In such a wire, in an outer side of the corner portion, generation of fine powder due to abnormal electrical discharge can be suppressed when dry etching by plasma is conducted. In addition, even if fine powder is generated, an inner side of the corner portion makes it possible to wash away the fine powder when cleaning without the fine powder remaining in the corner. As a result a yield improves significantly. Further, the round corner of the wire enhances electric conductivity. In addition, dusts in multiple parallel wires can be washed effectively.

In FIG. **43**A, n-channel transistors **5821** to **5824** and p-channel transistors **5825** and **5826** are formed. The n-channel transistor **5823** and the p-channel transistor **5825**, and the n-channel transistor **5824** and the p-channel transistor **5826** form inverters **5827** and **5828**, respectively. A circuit including these six transistors forms an SRAM. An insulating layer such as silicon nitride and silicon oxide may be formed over the transistors.

This embodiment can be conducted by freely combining with Embodiments 1 to 4.

Embodiment 6

In this embodiment, description is made on a structure where a substrate provided with pixels is sealed, with reference to FIGS. **25**A to **25**C. FIG. **25**A is a top view of a panel where a substrate provided with pixels is sealed, and FIGS. **25**B and **25**C are cross-sectional views taken along a line A-A' of FIG. **25**A. FIGS. **25**B and **25**C show examples where sealing is performed by different methods.

In FIGS. **25**A to **25**C, a pixel portion **2502** having a plurality of pixels is provided over a substrate **2501**, and a sealing material **2506** is provided so as to surround the pixel portion **2502**, while a sealing material **2507** is attached thereto. For the structure of pixels, those shown in embodiment modes or Embodiment 1 can be employed.

In the display panel in FIG. **25**B, the sealing material **2507** in FIG. **25**A corresponds to a counter substrate **2521**. The counter substrate **2521** which is transparent is attached to the substrate **2501** using the sealing material **2506** as an adhesive layer, and accordingly, a hermetically sealed space **2522** is formed by the substrate **2501**, the counter substrate **2521**, and the sealing member **2506**. The counter substrate **2521** is provided with a color filter **2520** and a protective film **2523** for protecting the color filter. Light emitted from light-emitting elements which are disposed in the pixel portion **2502** is emitted to the outside through the color filter **2520**. The hermetically sealed space **2522** is filled with an inert resin or liquid. Note that the resin for filling the hermetically sealed space **2522** may be a translucent resin in which moisture absorbent is dispersed. In addition, the same materials may be used for the sealing material **2506** and the hermetically sealed space **2522**, so that the adhesion of the counter substrate **2521** and the sealing of the pixel portion **2502** may be performed concurrently.

In the display panel shown in FIG. **25**C, the sealing material **2507** in FIG. **25**A corresponds to a sealing material **2524**. The sealing material **2524** is attached to the substrate **2501** using the sealing material **2506** as an adhesive layer, and a hermetically sealed space **2508** is formed by the substrate **2501**, the sealing material **2506**, and the sealing material **2524**. The sealing material **2524** is provided with a moisture absorbent **2509** in advance in its depressed portion, and the moisture absorbent **2509** functions to keep a clean atmosphere in the hermetically sealed space **2508** by adsorbing moisture, oxygen, and the like to suppress deterioration of the light-emitting elements. The depressed portion is covered with a fine-meshed cover material **2510**. The cover material **2510** transmits air and moisture but the moisture absorbent **2509** does not. Note that the hermetically sealed space **2508** may be filled with a rare gas such as nitrogen or argon, as well as an inert resin or liquid.

An input terminal portion **2511** for transmitting signals to the pixel portion **2502** and the like are provided over the substrate **2501**. Signals such as video signals are transmitted to the input terminal portion **2511** through an FPC (Flexible Printed Circuit) **2512**. At the input terminal portion **2511**, wires formed over the substrate **2501** are electrically connected to wires provided in the FPC **2512** with the use of a resin in which conductors (anisotropic conductive resin: ACF) are dispersed.

A driver circuit for inputting signals to the pixel portion **2502** may be formed over the same substrate **2501** as the pixel portion **2502**. Alternatively, the driver circuit for inputting signals to the pixel portion **2502** may be formed by an IC chip so as to be connected onto the substrate **2501** by COG (Chip-On-Glass) bonding, or the IC chip may be disposed on the substrate **2501** by TAB (Tape Automated Bonding) or by use of a printed board.

This embodiment can be conducted by freely combining with Embodiments 1 to 5.

Embodiment 7

The present invention can be applied to a display module where a circuit for inputting signals to a panel is mounted on the panel.

FIG. **26** shows a display module where a panel **2600** is combined with a circuit board **2604**. Although FIG. **26** shows an example where a controller **2605**, a signal dividing circuit **2606**, and the like are formed over the circuit board **2604**, circuits formed over the circuit board **2604** are not limited to these. Any circuit which can generate signals for controlling the panel may be employed.

Signals outputted from the circuits formed over the circuit board **2604** are inputted to the panel **2600** through a connecting wire **2607**.

The panel **2600** includes a pixel portion **2601**, a source driver **2602**, and a gate driver **2603**. The structure of the panel **2600** may be similar to those shown in Embodiments 1, 2, and the like. Although FIG. **26** shows an example where the source driver **2602** and the gate driver **2603** are formed over the same substrate as the pixel portion **2601**, the display module of the present invention is not limited to this. Such a structure may also be employed in which only the gate drivers **2603** are formed over the same substrate as the pixel portion **2601**, while the source driver **2602** is formed over a circuit board. Alternatively, both of the source driver and the gate drivers may be formed over a circuit board.

Display portions of various electronic appliances can be formed by incorporating such a display module.

This embodiment can be conducted by freely combining with Embodiments 1 to 6.

Embodiment 8

The present invention can be applied to various electronic appliances. The electronic appliances include a camera (e.g., a video camera or a digital camera), a projector, a head-mounted display (a goggle display), a navigation system, a car stereo, a computer, a game machine, a portable information terminal (e.g., a mobile computer, a portable phone, or an electronic book), an image reproducing device provided with a recording medium (specifically, a device for reproducing a recording medium such as a digital versatile disc (DVD), and having a display portion for displaying the reproduced image), and the like. FIGS. **27**A to **27**D show examples of the electronic appliances.

FIG. **27**A shows a notebook personal computer, which includes a main body **2711**, a housing **2712**, a display portion **2713**, a keyboard **2714**, an external connecting port **2715**, a pointing mouse **2716**, and the like. The present invention is applied to the display portion **2713**. With the present invention, power consumption of the display portion can be reduced.

FIG. **27**B shows an image reproducing device provided with a recording medium (specifically, a DVD reproducing device), which includes a main body **2721**, a housing **2722**, a first display portion **2723**, a second display portion **2724**, a recording medium (e.g., DVD) reading portion **2725**, an operating key **2726**, a speaker portion **2727**, and the like. The first display portion **2723** mainly displays image data, while the second display portion **2724** mainly displays text data. The present invention is applied to the first display portion **2723** and the second display portion **2724**. With the present invention, power consumption of the display portion can be reduced.

FIG. **27**C shows a portable phone, which includes a main body **2731**, an audio output portion **2732**, an audio input portion **2733**, a display portion **2734**, operating switches **2735**, an antenna **2736**, and the like. The present invention is applied to the display portion **2734**. With the present invention, power consumption of the display portion can be reduced.

FIG. **27**D shows a camera, which includes a main body **2741**, a display portion **2742**, a housing **2743**, an external connecting port **2744**, a remote controlling portion **2745**, an image receiving portion **2746**, a battery **2747**, an audio input portion **2748**, operating keys **2749**, and the like. The present invention is applied to the display portion **2742**. With the present invention, power consumption of the display portion can be reduced.

This embodiment can be conducted by freely combining with Embodiments 1 to 7.

Embodiment 9

In this embodiment, an application example of a display panel in which a display device using a pixel structure of the present invention is used for a display portion will be described with reference to drawings. The display panel in which a display device using a pixel structure of the present invention is used for a display portion, can be structured to be unified with a transportation unit, a building, or the like.

A transportation unit unified with a display device is shown in FIGS. **77**A and **77**B as one example of a display panel in which a display device using a pixel structure of the present invention is used for a display portion. FIG. **77**A shows an example of a transportation unit unified with a display device, in which a display panel **9702** is used in a glass portion of a door in a train-car **9701**. In the display panel **9702** having a display portion using a display device in which a pixel structure of the present invention shown in FIG. **77**A is applied, an image to be displayed on the display portion can be easily shifted by an external signal. Thus, images of the display panel can be changed as the type of train passenger changes in accordance with different time periods. Accordingly, more effective advertising can be expected.

Applications for the display panel in which a display device using a pixel structure of the present invention is used in the display portion are not limited to a glass portion of a door of a train-car as shown in FIG. **77**A. The shape of the display panel can be changed so that it can be set anywhere. FIG. **77**B shows an example thereof.

FIG. **77**B shows the inside of the train-car. In FIG. **77**B, a display panel **9703** provided on a glass window, and a display panel **9704** hung on a ceiling are shown, in addition to the display panel **9702** of the glass portion of the door shown in FIG. **77**A. The display panel **9703** equipped with a pixel structure of the present invention has a self-emission type display element. Thus, it is possible that images for advertisement be displayed when the train-car is crowded and be not displayed when the train-car is not crowded so that outside view can be seen from the train. By providing a switching element such as an organic transistor for a film-like substrate, and driving a self-emission type display element, the display panel **9704** itself having a pixel structure of the present invention can warp to display images.

FIG. **78** shows another application example of a transportation unit unified with a display device using a display panel having a display device in a display portion. The display device uses a pixel structure of the present invention in the display portion.

FIG. **78** shows an example of a transportation unit unified with a display device using a display panel having a display device in a display portion. The display device uses a pixel structure of the present invention in the display portion. FIG. **78** shows an example of a display panel **9902** unified with a car body **9901**, as an example of a transportation unit unified with a display device. The display panel **9902** having a display device using a pixel structure of the present invention in a display portion shown in FIG. **78** is attached so as to be unified with the car body, and has a function of displaying on-demand car movement or information input from inside or outside the car or a navigation function to the destination.

Note that a display panel having a display device using a pixel structure of the present invention in a display portion is not limited to being applied to a front portion of a car body as shown in FIG. **78**. By changing the shape, the display panel can be applied to any place, such as a glass window, a door, or the like.

FIGS. **79**A and **79**B show another application example of a transportation unit unified with a display device using a display panel having a display device in a display portion. The display device uses a pixel structure of the present invention in the display portion.

FIGS. **79**A and **79**B show an example of a transportation unit which is unified with a display panel having a display device in a display portion. The display device uses a pixel structure of the present invention. FIG. **79**A shows an example of a display panel **10102** which is unified with a ceiling above passengers inside an airplane body **10101**, as an example of a transportation unit unified with a display device. The display panel **10102** having a display device using a pixel structure of the present invention in a display portion shown in FIG. **79**A is attached so as to be unified with the airplane body **10101** with a hinge portion **10103**. Passengers can move the display panel **10102** with the hinge portion **10103** to watch and listen to the display panel. The display panel **10102** has a function of displaying information or being used for an advertisement and entertainment unit by an operation of a passenger. As shown in FIG. **79**B, the hinge portion folds to be stored in the airplane body **10101**, and thus, the safety can be maintained during takeoff and landing. In addition, by lighting the display element of the display panel in emergency, it can be used as a guidance light of the airplane body **10101**.

Note that a display panel having a display device using a pixel structure of the present invention in a display portion is not limited to being applied to a ceiling portion of the airplane body **10101** shown in FIGS. **79**A and **79**B. By changing its shape, it can be applied to anywhere, such as a passenger seat or a door. For example, a display panel may be provided on the back of the seat in front of the passenger, and the passenger may operate the display panel to watch or listen to it.

In this example, as a transportation unit, a train-car body, a car body, and an airplane body are given; however, the present invention is not limited thereto. The application range of the present invention is wide. For example, it includes an automobile two-wheeled vehicle, an automatic four-wheeled vehicle (including a car, a bus and the like), a train (including a monorail, a railroad train and the like), a ship and the like. By applying a display panel having a display portion using a pixel structure of the present invention, downsizing and low power consumption of the display panel are achieved, and a transportation unit equipped with a display medium which operates well can be provided. In particular, since display of display panels in a transportation unit can be easily changed all at once by an external signal, they are extremely effective as display devices for advertisement or information display in emergency aimed at the general public or a large number of passengers.

As an application example in which a display panel having a display device using a pixel structure of the present invention is used, an application mode applied to a building is described with reference to FIG. **80**.

FIG. **80** shows an application example of a display panel which can be warped by providing a switching element such as an organic transistor over a film substrate, and driving a self-emission display element, to display an image. The display panel is shown as an example of a display panel in which a display device using a pixel structure of the present invention is used in a display portion. In FIG. **80**, a case where a display panel is provided on a curved surface of a columnar building such as a telephone pole provided outside as a building is shown. Here, the display panel **9802** is provided on a telephone pole **9801** which is has a columnar body.

The display panel **9802** shown in FIG. **80** is located in a position which is in about the middle of the height telephone pole, at a higher point than a human viewpoint. When the display panel is seen from a transportation unit **9803**, an image displayed on the display panel **9802** can be recognized. Display panels are provided on telephone poles standing in a large number in outdoors so as to display the same image, and thus, displayed information or advertisement can be made visible to viewers. The display panels **9802** provided on the telephone poles **9801** of FIG. **80** can be easily made to display an image externally. Thus, extremely effective information for display and advertisement effect can be expected. By providing a self-emission type display element as a display element in a display panel of the present invention, the display panel is effective as a highly visible display medium even at night.

FIG. **81** shows another application example of a building with which a display panel having a display device using a pixel structure of the present invention in a display portion is unified, which is different from that shown in FIG. **80**.

FIG. **81** shows an application example of a display panel having a display device using a pixel structure of the present invention in a display portion. FIG. **81** shows an example of a display panel **10002** which is unified with an inner wall of a prefabricated bath **10001**, as an example of a transportation unit unified with a display device. The display panel **10002** having a display device using a pixel structure of the present invention in a display portion shown in FIG. **81** is attached so as to be unified with the prefabricated bath **10001**, and a bather can watch and listen to the display panel **10002**. The display panel **10002** can have a function of displaying information or can be used as a means for an advertisement and entertainment by an operation of a bather.

The display panel having a display device using a pixel structure of the present invention in a display portion is not limited to being applied to only the side wall of the prefabricated bath **10001** shown in FIG. **81**. By changing its shape, it can be applied to anywhere such as a part of a mirror or a bathtub itself.

FIG. **82** shows an example in which a television apparatus having a large display portion is provided in a building. FIG. **82** includes a housing **2010**, a display portion **2011**, a remote controller device **2012** which is an operating portion, a speaker **2103**, and the like. A display panel which includes the display device using the pixel structure of the present invention in a display portion is applied for manufacturing the display portion **2011**. A television apparatus shown in FIG. **82** is hung on the wall to be unified with the building, therefore, can be provided without requiring a wide space.

In this embodiment, a telephone pole which is an example of a columnar body or a prefabricated bath is given as an example of a building; however, this embodiment is not limited thereto and any structure can be adopted as long as it can be equipped with a display panel. By applying a display device using a display portion using a pixel structure of the present invention, downsizing and low power consumption of a display device can be achieved, and a transportation unit equipped with a display medium with favorable operation can be provided.

This application is based on Japanese Patent application No. 2005-245467 filed on Aug. 26, 2005 with the Japanese Patent Office, the entire contents of which are hereby incorporated by reference.

What is claimed is:

1. A display device comprising:
a battery;
a pixel portion including a plurality of light-emitting elements;
a source driver for driving the pixel portion;
a timer circuit;
a charging unit detection circuit; and
a driving method selection circuit,
wherein the timer circuit outputs a first signal for proceeding to a second burn-in correction period when a predetermined time passes after an end of a first burn-in correction period through a first normal driving period in which an image is displayed,
wherein the charging unit detection circuit outputs a second signal for proceeding to the second burn-in correction period when the battery is charged,
wherein the driving method selection circuit outputs a third signal for proceeding to the second burn-in correction period from the first normal driving period when the first signal and the second signal are inputted, and proceeding to a second normal driving period from the second burn-in correction period when the first signal and the second signal are not inputted, and
wherein characteristics of the plurality of light-emitting elements are obtained by making the plurality of light-emitting elements emit light one by one in the first burn-in correction period, and by making light-emitting elements of red, blue and green emit light at a same time in the second burn-in correction period.

2. A display device comprising:
a pixel portion including a plurality of light-emitting elements;
a source driver for driving the pixel portion;
a timer circuit;
a non-operating detection circuit; and
a driving method selection circuit,
wherein the timer circuit outputs a first signal for proceeding to a second burn-in correction period when a predetermined time passes after an end of a first burn-in correction period through a first normal driving period in which an image is displayed,
wherein the non-operating detection circuit outputs a second signal for proceeding to the second burn-in correction period when the display device is not turned on for a predetermined time,
wherein the driving method selection circuit outputs a third signal for proceeding to the second burn-in correction period from the first normal driving period when the first signal and the second signal are inputted, and for proceeding to a second normal driving period from the second burn-in correction period when the first signal and the second signal are not inputted, and
wherein characteristics of the plurality of light-emitting elements are obtained by making the plurality of light-emitting elements emit light one by one in the first burn-in correction period, and by making light-emitting elements of red, blue and green emit light at a same time in the second burn-in correction period.

3. A display device comprising:
a battery;
a pixel portion including a plurality of light-emitting elements;
a source driver for driving the pixel portion;
a timer circuit;
a charging unit detection circuit;
a surrounding luminance detection circuit; and
a driving method selection circuit,
wherein the timer circuit outputs a first signal for proceeding to a second burn-in correction period when a predetermined time passes after an end of a first burn-in correction period through a first normal driving period in which an image is displayed,
wherein the charging unit detection circuit outputs a second signal for proceeding to the second burn-in correction period when the battery is charged,
wherein the surrounding luminance detection circuit outputs a third signal for proceeding to the second burn-in correction period when surrounding luminance around the display device is close to a predetermined luminance,
wherein the driving method selection circuit outputs a fourth signal for proceeding to the second burn-in correction period from the first normal driving period when the first signal, the second signal, and the third signal are inputted, and for proceeding to a second normal driving period from the second burn-in correction period when the first signal, the second signal, and the third signal are not inputted, and
wherein characteristics of the plurality of light-emitting elements are obtained by making the plurality of light-emitting elements emit light one by one in the first burn-in correction period, and by making light-emitting elements of red, blue and green emit light at a same time in the second burn-in correction period.

4. A display device comprising:
a pixel portion including a plurality of light-emitting elements;
a source driver for driving the pixel portion;
a timer circuit;
a non-operating detection circuit;
a surrounding luminance detection circuit; and
a driving method selection circuit,
wherein the timer circuit outputs a first signal for proceeding to a second burn-in correction period when a predetermined time passes after an end of a first burn-in correction period through a first normal driving period in which an image is displayed,
wherein the non-operating detection circuit outputs a second signal for proceeding to the second burn-in correction period when the display device is not turned on for a predetermined time,
wherein the surrounding luminance detection circuit outputs a third signal for proceeding to the second burn-in correction period when surrounding luminance around the pixel portion of the display device is close to a predetermined luminance,
wherein the driving method selection circuit outputs a fourth signal for proceeding to the second burn-in correction period from the first normal driving period when the first signal, the second signal, and the third signal are inputted, and for proceeding to a second normal driving period from the second burn-in correction period when the first signal, the second signal, and the third signal are not inputted, and

wherein characteristics of the plurality of light-emitting elements are obtained by making the plurality of light-emitting elements emit light one by one in the first burn-in correction period, and by making light-emitting elements of red, blue and green emit light at a same time in the second burn-in correction period.

5. A display device comprising:

a pixel portion including a plurality of light-emitting elements;

a source driver for driving the pixel portion;

a timer circuit; and

a driving method selection circuit,

wherein the timer circuit outputs a first signal for proceeding to a second burn-in correction period when a predetermined time passes after an end of a first burn-in correction period through a first normal driving period in which an image is displayed,

wherein the driving method selection circuit outputs a second signal for proceeding to the second burn-in correction period from the first normal driving period when the first signal is inputted, and for proceeding to a second normal driving period from the second burn-in correction period when the first signal is not inputted, and

wherein characteristics of the plurality of light-emitting elements are obtained by making the plurality of light-emitting elements emit light one by one in the first burn-in correction period, and by making light-emitting elements of red, blue and green emit light at a same time in the second burn-in correction period.

6. The display device according to claim **1**, wherein the characteristic of the plurality of light-emitting elements included in the pixel portion is obtained by detecting current flowing to a counter electrode of the plurality of light-emitting elements in the first burn-in correction period.

7. The display device according to claim **2**, wherein the characteristic of the plurality of light-emitting elements included in the pixel is obtained by detecting current flowing to a counter electrode of the plurality of light-emitting elements in the first burn-in correction period.

8. The display device according to claim **3**, wherein the characteristic of the plurality of light-emitting elements included in the pixel is obtained by detecting current flowing to a counter electrode of the plurality of light-emitting elements in the first burn-in correction period.

9. The display device according to claim **4**, wherein the characteristic of the plurality of light-emitting elements included in the pixel is obtained by detecting current flowing to a counter electrode of the plurality of light-emitting elements in the first burn-in correction period.

10. The display device according to claim **5**, wherein the characteristic of the plurality of light-emitting elements included in the pixel is obtained by detecting current flowing to a counter electrode of the plurality of light-emitting elements in the first burn-in correction period.

11. The display device according to claim **1**, wherein the characteristic of the plurality of light-emitting elements in the pixel is obtained by detecting current flowing in a power supply line of the plurality of light-emitting elements in the first burn-in correction period.

12. The display device according to claim **2**, wherein the characteristic of the plurality of light-emitting elements in the pixel is obtained by detecting current flowing in a power supply line of the plurality of light-emitting elements in the first burn-in correction period.

13. The display device according to claim **3**, wherein the characteristic of the plurality of light-emitting elements in the pixel is obtained by detecting current flowing in a power supply line of the plurality of light-emitting elements in the first burn-in correction period.

14. The display device according to claim **4**, wherein the characteristic of the plurality of light-emitting elements in the pixel is obtained by detecting current flowing in a power supply line of the plurality of light-emitting elements in the first burn-in correction period.

15. The display device according to claim **5**, wherein the characteristic of the plurality of light-emitting elements in the pixel is obtained by detecting current flowing in a power supply line of the plurality of light-emitting elements in the first burn-in correction period.

16. The display device according to claim **1**, wherein the characteristic of the plurality of light-emitting elements in the pixel portion in a region in which deterioration of the characteristics is supposed to be easily generated is obtained preferentially in the first burn-in correction period.

17. The display device according to claim **2**, wherein the characteristic of the plurality of light-emitting elements in the pixel portion in a region in which deterioration of the characteristics is supposed to be easily generated is obtained preferentially in the first burn-in correction period.

18. The display device according to claim **3**, wherein the characteristic of the plurality of light-emitting elements in the pixel portion in a region in which deterioration of the characteristics is supposed to be easily generated is obtained preferentially in the first burn-in correction period.

19. The display device according to claim **4**, wherein the characteristic of the plurality of light-emitting elements in the pixel portion in a region in which deterioration of the characteristics is supposed to be easily generated is obtained preferentially in the first burn-in correction period.

20. The display device according to claim **5**, wherein the characteristic of the plurality of light-emitting elements in the pixel portion in a region in which deterioration of the characteristics is supposed to be easily generated is obtained preferentially in the first burn-in correction period.

21. The display device according to claim **6**, wherein a potential of the counter electrode in the first burn-in correction period is same as that of the counter electrode in the first normal driving period.

22. The display device according to claim **7**, wherein a potential of the counter electrode in the first burn-in correction period is same as that of the counter electrode in the first normal driving period.

23. The display device according to claim **8**, wherein a potential of the counter electrode in the first burn-in correction period is same as that of the counter electrode in the first normal driving period.

24. The display device according to claim **9**, wherein a potential of the counter electrode in the first burn-in correction period is same as that of the counter electrode in the first normal driving period.

25. The display device according to claim **10**, wherein a potential of the counter electrode in the first burn-in correction period is same as that of the counter electrode in the first normal driving period.

26. The display device according to claim **11**, wherein a potential of the power supply line in the first burn-in correction period is same as that of the power supply line in the first normal driving period.

27. The display device according to claim **12**, wherein a potential of the power supply line in the first burn-in correction period is same as that of the power supply line in the first normal driving period.

28. The display device according to claim 13, wherein a potential of the power supply line in the first burn-in correction period is same as that of the power supply line in the first normal driving period.

29. The display device according to claim 14, wherein a potential of the power supply line in the first burn-in correction period is same as that of the power supply line in the first normal driving period.

30. The display device according to claim 15, wherein a potential of the power supply line in the first burn-in correction period is same as that of the power supply line in the first normal driving period.

31. The display device according to claim 1, wherein a driving frequency in the first burn-in correction period is same as that of the first normal driving period.

32. The display device according to claim 2, wherein a driving frequency in the first burn-in correction period is same as that of the first normal driving period.

33. The display device according to claim 1, wherein the display device is incorporated in one selected from the group consisting of a computer, an image reproducing device, a phone, and a camera.

34. The display device according to claim 2, wherein the display device is incorporated in one selected from the group consisting of a computer, an image reproducing device, a phone, and a camera.

35. The display device according to claim 3, wherein the display device is incorporated in one selected from the group consisting of a computer, an image reproducing device, a phone, and a camera.

36. The display device according to claim 4, wherein the display device is incorporated in one selected from the group consisting of a computer, an image reproducing device, a phone, and a camera.

37. The display device according to claim 5, wherein the display device is incorporated in one selected from the group consisting of a computer, an image reproducing device, a phone, and a camera.

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